CIVIL ENGINEERING

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Volume 10 Number 5

MAY 1940

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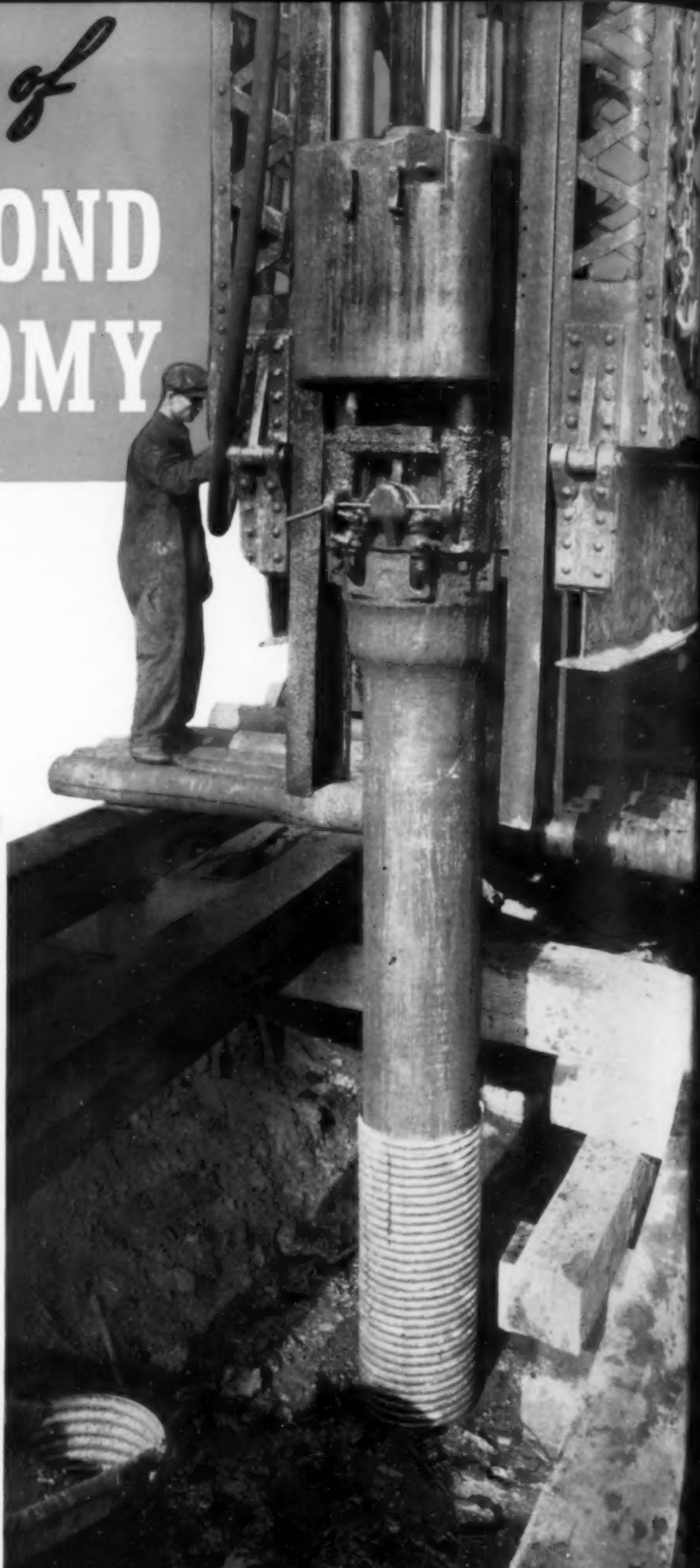

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Among Our Writers

William J. Wilgus in 1899, at but 33 years of age, was appointed chief engineer of the New York Central. As private consultant from 1907 until his retirement in 1931, he was in continuous demand on transportation, municipal, and public enterprises. For his war work in France as director general of military railways and deputy director general of transportation, he was cited for distinguished service.

C. W. Mengel (U. of Nebraska, 1910) was drainage engineer for the U.S. Department of Agriculture and the John L. Roper Lumber Company for 10 years, and was associated with W. C. Olsen, consulting engineer of Raleigh, N.C., for 12 years. Before becoming director of the Greensboro Department of Public Works and Service, he was chief engineer of the North Carolina PWA office.

Seth G. Hess (Cornell U., 1915) has been chief engineer and executive secretary of the Interstate Sanitation Commission since 1937. He has been a consulting sanitary engineer with Alexander Potter and Morris Knowles, Inc., and at one time was assistant state engineer inspector for the PWA in New York.

J. W. Bradner, Jr. (U. of Cincinnati, 1925) has been construction superintendent on highways, municipal developments, and utilities; has designed highways, parkways, water works, sewer systems, and parks; and has written on social and economic subjects.

Charles V. Theis (U. of Cincinnati, C.E., 1922; Ph.D., 1929) has been engaged in quantitative ground-water investigations in the Southwest for 10 years, and is at present Geologist in Charge of Ground-Water Investigations in New Mexico for the U.S. Geological Survey. He is the author of numerous papers dealing with ground water.

J. A. Meehan is at present acting chief engineer for the Department of Docks in charge at the N.Y. Municipal Airport, La Guardia Field. He is now starting construction of several new structures there and is directing the completion of four piers on the North River and a section of the East River Drive.

Jonathan Jones (U. of Pennsylvania, 1906) was engineer of bridges for the City of Philadelphia for 7 years, and was with the McClintic-Marshall Company for 18 years, designing and constructing the Ambassador Bridge at Detroit during the latter period. Since 1931 he has been chief engineer of the fabricating interests of the Bethlehem Steel Company.

T. Keith Legaré, former Director of the Society, was for 12 years with the city of Columbia, S.C., in various capacities including that of city engineer. From 1920 to 1928 he was Southern district manager for Dow and Smith, of New York City. He has been with the National Council of State Boards of Engineering Examiners since 1923.

Murray D. Van Wagoner (U. of Michigan, 1921) served as bridge engineer for the Michigan State Highway Department and, later, maintained his own engineering practice. He was elected Michigan State Highway Commissioner in 1933 and again in 1937, and is president of the American Road Builders Association.

Brehon B. Somervell (U.S. Military Academy, 1914) served in France during the World War as chief of staff of the 89th Division, continuing as assistant chief of staff with the Army of Occupation. He was later Assistant or District Engineer in the New York and other districts. Since 1936 he has been WPA Administrator for New York City.

Clark H. Eldridge was bridge engineer for the city of Seattle from 1928 to 1936, and for the Washington State Highway Department from the latter year to 1939. He then accepted a similar position with the Washington Toll Bridge Authority.

W. W. Horner (Washington U., 1905; C.E., 1909) a former Director of the Society, is a consulting engineer, and professor of hydraulic and sanitary engineering at Washington U. Erwin R. Breihan and H. G. Armistead are senior students at the University, and members of the Society's Student Chapter.

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Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

Commemorating the Civil Engineer

A Plea for Greater Recognition—by the Naming of Monumental Structures in Honor of Their Creators

By WILLIAM J. WILGUS
HONORARY MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
ASCUTNEY, VT.

FROM time immemorial it has been the custom among men to honor those who in some marked degree have given of themselves for the advancement of the race. Their example has been recognized as a potent influence in the molding of the character of those who come after them. As was said by Terence, one of the wise men of antiquity, man should "look into the lives of others as though into a mirror, and from others to take an example for himself." Or, in the words of Burke, "Example is the school of mankind, and they will learn at no other." Looking backward on high achievement inspires mankind for the task ahead. To ignore it is to dwarf or kill the spirit.

Recognizing Age-Old Truth.—So man has perpetuated the memory of the great in literature and art. Who in his youth has not been spurred to emulate high purpose by reading Plutarch's *Lives?* The naming of great cities and of numberless mountains, rivers, lakes, and wide areas throughout the world bears witness to the instinctive effort of man to gain strength from the examples set by those from whom he would draw inspiration.

But the civil engineer has had a comparatively brief past from which to fire his imagination. His profession did not come into being as such until the invention of the Watt steam engine, 170 years ago, gave birth in Great Britain to private and public works on a vastly increasing scale. With the growth in output of the products of industry made possible by this invention came the impelling call for better highways and more commodious harbors; then lighthouses, canals, and improved water supply and sanitation; and finally railways and vessels propelled by steam. All these brought with them the need for works of unprecedented boldness and ingenuity. So the names of Telford, Smeaton, Macadam, Brunel, and Stephenson became immortal.

In America Also.—In our own newly settled country it was but natural that the civil engineer should come into being a generation later than in Great Britain. The gaining of our independence, and the attainment of full statehood in 1789, then gave us an impetus that quickly called for new means of transportation. The warnings of Washington that neglect in this particular might lose to us the West had their part in giving life to the steamboat inventions of Henry, Fitch, Rumsey, and Morey, and the amphibian of Oliver Evans, all of which had their climax in the *Clermont* of Robert Fulton in 1807.

Shortly after, in 1812, Col. John Stevens, who had been prominent in the development of the steamboat, gave voice to the prophecy that railroads would prove to be the preferable means of inland transportation, at the same time that DeWitt Clinton was advocating the creation of the Erie Canal. In fact, it was in 1815 that Stevens obtained the first railroad charter in America, the precursor of the Pennsylvania Railroad, which has earned for him the title of father of American railroading. Along with these activities went proposals for the building of the cross-country Cumberland Road or National Turnpike from connections with Philadelphia, Baltimore, and Washington to the Mississippi River, and also the creation of public buildings, harbor improvements, and water works in the larger communities.

Two Great Leaders.—Out of this ferment, raised as it was to the boiling point by the examples set by the engineers of Great Britain and France, came two schools in which the founders of our profession in this country were trained—that headed by Benjamin Wright in connection with the location and construction of the Erie Canal, and that of Benjamin H. Latrobe in connection with the development of the city of Washington and various projects in Philadelphia, Baltimore, and New Orleans. Under these two, civil engineering as an active profession distinct from architecture had its beginnings in America at the close of the War of 1812, a century and a quarter ago.

Associated with Benjamin Wright in the building of the Erie Canal between 1817 and 1825 were four remark-

able men who subsequently were identified not only with the design and construction of other canals, but some of them with water works and other public works and, above all, with railroads from their very start in 1829–1830. They were James Geddes; Canvass White, who won fame as an expert in the design of locks and as the originator of the manufacture of hydraulic cement in America; Nathan S. Roberts, whose name became identified with the building of the Chesapeake and Ohio Canal and preliminary work on the Baltimore and Ohio Railroad; and John B. Jervis, the inventor of the bogie truck, whose versatility was displayed in the creation of the parent portions of the canal and railway of the Delaware and Hudson Company, the New York Central Railroad, the Chicago, Rock Island and Pacific Railway, and the Pittsburgh, Fort Wayne and Chicago Railway, as well as the water supplies of the cities of New York and Boston.

Four More Notables.~Turning now to the group of engineers who owed their training to Latrobe, again four men stand out in sharp relief. Of these Frederick Graff is to be mentioned as the creator of the first water supply system of magnitude, that at Philadelphia in 1822; Robert Mills as the architect of many notable structures, including the Treasury building in Washington and the monuments erected to the father of our country in Baltimore and Washington, and as the engineer of the water works of Baltimore and of the state of South Carolina after 1820; William Strickland, as the architect of numerous historic objects and engineer of the Pennsylvania State Canal, the Delaware Breakwater, and the proposed railroad between Wilmington, Del., and the Susquehanna River in 1835, and as the author of an important report on the canals, roads, railways, and bridges of Great Britain in 1825; and finally, Benjamin Latrobe II, identified with the beginnings of the Baltimore and Ohio Railroad and eventually its chief engineer (in succession to Jonathan Knight) who was early connected with the building of the National Turnpike and who was a commanding figure in the first days of railroading in the United States.

From this galaxy of illustrious pioneers in a spiritual sense has sprung the multitude who have since practiced the profession for which they laid the foundations. To the American Society of Civil Engineers since its birth in 1852 has fallen the pleasing duty of honoring such of them as have been deemed to be "of acknowledged eminence in some branch of engineering or the sciences related thereto" or otherwise worthy of high distinction. These, in addition to others recognized in standard biographies, may be said to number some 200 American engineers.

From Many Engineering Fields.~Of them the larger number by far, in any one branch of the profession, have devoted their lives to railroads, a feature of our national development once in the fore but now at the turning point of its existence. Public works may be said to stand next in order, in so far as the number of eminent engineers is concerned. In the bridge field the number of outstanding engineers is not far different from that in the field of public works. Hydraulic engineering may be said to come next in number of practitioners, and then the group that had to do with tunnels, subways, dams, and deep foundations, followed in the order named by the educators of the profession, municipal engineers, manufacturers, marine engineers, physicists, and electrical engineers.

Space unfortunately forbids that here should be detailed an exhaustive list of the profession's illustrious dead. Such a list would serve to remind us of their noble exploits, for they, and the examples that they have set, must not be forgotten. How best then can we give them recognition, so that in time they will not be swallowed up in oblivion?

A Variety of Monuments.~To begin with, it would seem that where appropriate their statues should be erected on the scene of their more striking accomplishments, as has been done in the case of Samuel Spencer before the station of the Southern Railway in Atlanta, Ga.; of Samuel Rea and Alexander J. Cassatt in the Pennsylvania Railroad Station in New York; and of the living John F. Stevens at the pass bearing his name in the Cascade Mountains. Also their names should be attached to institutions, structures, enterprises, and places of note, as illustrated by the Stevens Institute of Technology; the Thayer School of Engineering at Dartmouth College; the town of Geddes in Onondaga County, N.Y.; the city of Port Jervis, N.Y.; the Burden Iron Works at Troy; the Eads Bridge at St. Louis; Fort Totten in New York; the Poe and Weitzel Locks at Sault Ste. Marie; the Gaillard Cut at the Panama Canal; the Holland Tunnel, New York; Lake Mead in Arizona; the town of Pegram in Idaho; the Morris, Merriman, Saville, and Winsor dams; the Goethals and Cooley bridges; the Chanute Air Field in Illinois; and the modern locomotive named in honor of Horatio Allen.

There are no doubt many others to whom such honors have been paid. Yet their number still is far too few. Engineers holding executive positions have before them a priceless opportunity, in the enterprises over which they hold sway, to enlarge this list in honor of both the dead and the living for the inspiration of those who come after.

Engineers' Due Reward.~Another way in which this end can be served is for the Society to encourage the preparation of an illustrated, highly readable account of the fascinating careers and human attributes of our early engineers, together with a description of the conditions of their day, very much as has been done in Great Britain in Smiles' *Lives of the Engineers*. Moreover, it would seem proper that steps should be taken to have included in future supplemental volumes of the *Dictionary of American Biography* such of the lives of the Society's honored dead as heretofore have been omitted from that Valhalla.

One further word—the Society might well institute measures to bring about the attachment of the name of the engineer to the products of his imagination, as is ever done with that of the architect, author, sculptor, musician, and painter. Man lives not by bread alone. In his praiseworthy pride of accomplishment he gains a reward not to be gaged by money. Its recognition is his due and that of his profession, and to the public it clothes with human interest what otherwise is void of spirit. In honoring our great, we will honor our profession and, above all, furnish to the young those lofty examples after which they may pattern their careers.

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Number 5

Observations on Textile Waste Treatment

Difficulties Met and Overcome in Two Years' Operation of New Greensboro, N.C., Plant

By C. W. Mengel

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Director of Public Works and Service, City of Greensboro, Greensboro, N.C.

Starting two years ago, the new North Buffalo $6^1/_2$-million-gal sewage treatment plant of Greensboro, N.C., began treatment of domestic sewage. After six months of relatively satisfactory operation, textile wastes were added. Among other results, the amount of ferric chloride for conditioning had to be approximately doubled, while the unit costs of operation increased 50%. Treatment of combined wastes has shown the need of increasing the detention time in primary basins, the air supply, and the digestion capacity over that required for domestic sewage. Also, collaboration between sanitary and mill authorities proved indispensable. This paper originated at the January 1940 meeting of the North Carolina Section, and appeared in the February issue of the Section's "North Carolina Civil Engineer."

Successful treatment of industrial wastes, together with normal domestic sewage, even in a plant designed for such joint operation, is not a simple matter. Yet, if experience in our Greensboro work is any criterion, the difficulties can be solved by study and collaboration of the sanitary and factory officials. In presenting the results of these experiences, it should be made clear that the viewpoint is an administrative one, rather than the purely technical standpoint of either the operator or the designer.

The North Buffalo treatment plant was constructed to treat the sewage from the northern portion of the City of Greensboro, which area includes the greater portion of the business section, a large portion of the newer residential section, and the mills of the Proximity Manufacturing Company with their villages. The outfall sewer to the plant has a carrying capacity of 13 mgd, and the plant itself was designed to treat 6.5 mgd.

Briefly, the plant consists of a raw sewage meter, communitors, detritors or grit chambers, flash mixer and flocculator, primary sedimentation basins, aeration tanks, secondary tanks, digesters, gas holder and elutriation tanks, with equipment for vacuum filtration of sludge. The plant is so arranged that practically any unit may be bypassed, while the several sections of the flocculator, primary tanks, aeration tanks, and secondary tanks may be operated in parallel or in series. The flexibility of the plant has been of great value in its operation. Designed detention periods for primary, secondary, and aeration tanks are $2^1/_2$ hours, 3 hours, and 6 hours, respectively, and the capacity of the digesters is approximately 2 cu ft per capita. The outline of the plant is shown in Fig. 1.

The plant was placed in operation July 15, 1938, and for obvious reasons only domestic sewage was treated for the first six months. During this period the treatment consisted of flocculation, primary sedimentation, aeration, and secondary sedimentation, with vacuum filtration of sludge after digestion and elutriation. Excess activated sludge was returned ahead of the primary tanks and, combined with settled raw sludge, was pumped to the digesters. No particular difficulty in this operation was apparent while domestic sewage was being treated. The average removal of suspended solids and reduction in B.O.D. was 92.0% and 92.3%, respectively. Digesters were not seeded, but lime was added as follows: July, 6,200 lb; August, 15,000 lb; and September, 15,800 lb. The gas meter recorded an output of 20,000 cu ft during July; 1,463,410 during August, and 1,993,006 during September. Since that month production of gas has averaged approximately 75,000 cu ft per day. Sludge was first filtered during September, some sixty days after the beginning of plant operation. Ferric chloride was used as a conditioner and the average percentage of conditioner used on a dry basis was:

September	8.30	November	9.86
October	6.18	December	6.53

While this amount was not as low as expected, it was the minimum that could be used to prepare the sludge cake so it could be removed in the vertical sludge elevator.

Use of gas for generating power began during the month of September 1938, and during that month 94% of the power used was generated in the plant. In succeeding months while domestic sewage only was handled, the percentage of power generated was:

October	94.6	December	100.0
November	99.5	January	100.0
February	99.0		

After February, when textile wastes were being introduced in increasing quantities, the percentage decreased, as will be stated later. During the same period the average volume of air per gallon of sewage used in the aeration tanks was 0.74 cu ft. The variations in these quantities are shown in Fig. 2.

Situated along the outfall sewer on North Buffalo Creek are textile manufacturing establishments known

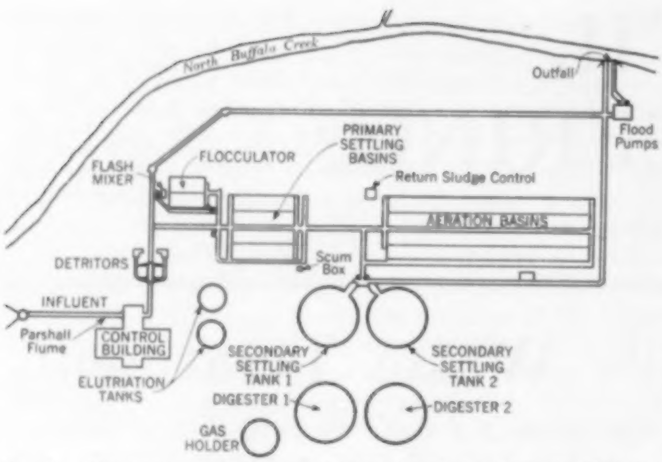


FIG. 1. SKELETON LAYOUT OF NORTH BUFFALO SEWAGE TREATMENT PLANT, GREENSBORO, N.C.

as Proximity Mills, White Oak Mills, Revolution Mills, and the Print Works. From these plants are wasted almost every type of dye and treatment liquor known in the textile trade, including sulfur black, indigo, kier liquor, raw stock dyes, and hydrosulfite waste. Sensing the need for treatment of these wastes to ameliorate existing stream pollution, the Proximity Manufacturing Company contributed a portion of the cost of the treatment plant and has assumed the cost of those chemicals whose use is directly attributable to dye waste treatment.

Prior to beginning plant operation, the wastes from White Oak and the Print Works were discharged into a collecting pond and disposal was made by pumping from this pond onto a spray field or by directly discharging into North Buffalo Creek. These wastes were the first to be carried to the North Buffalo Plant for treatment, and at this time are the only ones so treated. The spent kier liquors and dyes from Revolution Mill and the indigo, hydrosulfite and stock dye waste from Proximity Mill are still untreated when discharged into North Buffalo Creek. Depending upon mill operations, the discharge from Print Works and White Oak varies from 300,000 gpd to 1,000,000 gpd. It is anticipated that the discharge from Revolution and Proximity will not exceed 500,000 gpd under the present manufacturing processes.

The discharge from the existing dye pond now enters the outfall sewer, nearby, through a control device whereby the volume may be varied according to the amount of domestic sewage in the outfall, or may be manually controlled when desired. In any event it is accurately metered. It is anticipated that some work will be done on this pond to insure better mixing of the different wastes discharging therein, but on the whole the pond is serving its purpose. The mills propose now to construct another pond for collecting the Proximity and Revolution wastes farther upstream along the outfall. There will be constructed, also, apparatus for acid dosing and automatic pH control just below the existing dye pond. It is believed that, in this manner, accurate control of all waste elements can be established.

It would be gratifying if it could be stated that, after introduction of wastes, plant routine was not changed, and that operating results were as satisfactory as before, at no additional unit cost of treatment. After introduction of wastes into the plant on January 21, 1939, there was a lag of perhaps two months before additional problems caused by this addition became evident. The chart (Fig. 2) shows this, especially as it applies to B.O.D.; the percentage of total power generated by the plant; and the number of cubic feet of air per gallon of sewage required for proper aeration.

Normal operation after introduction of wastes consists in the addition of sulfuric acid to adjust the pH, introduction of alum as a coagulant before flash mixing, flocculation, primary sedimentation, aeration, and secondary settling. At times flocculation is omitted when colors are not heavy. The effluent, when wastes are not being handled, is clear, sparkling, and stable. When heavy quantities of waste, especially kier liquor, are being treated the effluent is clear but with a varying amber tinge which is not particularly objectionable.

Mention has heretofore been made of the results obtained from elutriation and vacuum filtration and of the fact that from 6.18 to 9.86% of ferric chloride was used to condition the elutriated sludge for filtration. After wastes were being treated the percentage increased as follows:

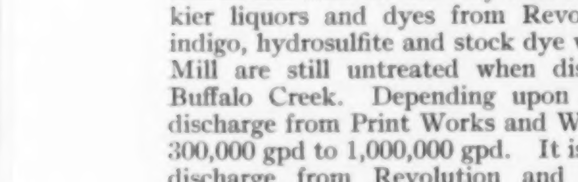
January	11.78		April	29.2	lime
February	13.68			8.6	iron
March	2.55	lime	May	17.5	
	19.75	iron	June	20.6	
July	22.5				

It was found that the character of the sludge had changed to such an extent that even with so high a percentage of conditioner the machinery for removing the sludge would not handle the filter cake and it was decided to abandon the vertical bucket elevator for that service. Instead, a belt conveyor has been installed which will take the filter cake from the filters and which we hope will handle it without further difficulty. The amount of conditioner that will be necessary to prepare the sludge for that type of conveying is not yet determined.

The effect of wastes on sludge was evident early. The practice of returning excess activated sludge ahead of the primary tanks had to be abandoned soon after introduction of wastes to the plant. At this time the excess activated sludge is thickened in one of the elutriation tanks and is pumped to the digesters separately from raw settled sludge. The method which worked quite well on domestic sludge failed entirely when sludge from combined and domestic wastes was being handled.

Another step involving sludge and affected by the change from domestic wastes to combined wastes, was the return of activated sludge to the aeration tanks. Routine operation called for return sludge to be collected in a concrete box near the head of the aeration tanks. Distribution to the aeration tanks was from this box through four lines of pipe, one to each division of the aeration tank. Shortly after wastes were introduced it was found that there was deterioration in the quality of this return sludge which affected processes all the way through to the effluent.

It was evident that re-aeration was required before mixing with the incoming sewage. To accomplish this, all the return sludge was delivered to one section of the aeration tanks through a submerged pipe discharging at the far end of the tank. This end was blocked, the flow reversed, and treated with a large volume of air while traveling through. It then was mixed with the influent to the aeration basin and the combination treated with



GENERAL VIEW OF NORTH BUFFALO PLANT
In Foreground Are Aeration Basins and in Background

air to the discharge end of another section. Then it traveled through the central channel to the front end of the tanks, where it was carried on through the two remaining sections to the secondary tank. This adjustment cleared up the trouble and is being used at the present time. The advantages of flexibility were thoroughly demonstrated here.

After several months of operation, no sludge bulking of any consequence had occurred, and with the exception of sludge-disposal troubles the outlook was fairly bright. One day after several days of exceptionally good effluent, the secondary tanks suddenly took on the appearance of turbulent black clouds. Tests showed that the pH had changed in a few hours from near the neutral point to approximately 11.5, and upon inquiry at the mill it developed that the kier vats had been discharging beyond any quantity theretofore handled. A temporary acid treating station was soon erected and in a day or so the effluent was back to normal. Since that time the mill superintendents have notified the plant superintendent of any unusual dumping, and time has been available in which to prepare for the anticipated condition.

From February 1939, through October 1939, 189,170,000 gal of dye waste were treated at the plant, at a cost per million gallons for chemicals only of $46.32. This does not cover the cost of additional power shown to have been necessary over that used in normal operations without waste, or any other of the usual charges. It is for chemicals only and the cost is borne by the Proximity Manufacturing Company.

During a period extending over 16 months the average cost of operation per million gallons, domestic sewage only, was $11.59, with a maximum of $16.83 in June and a minimum of $6.73 in January. The excessive cost in

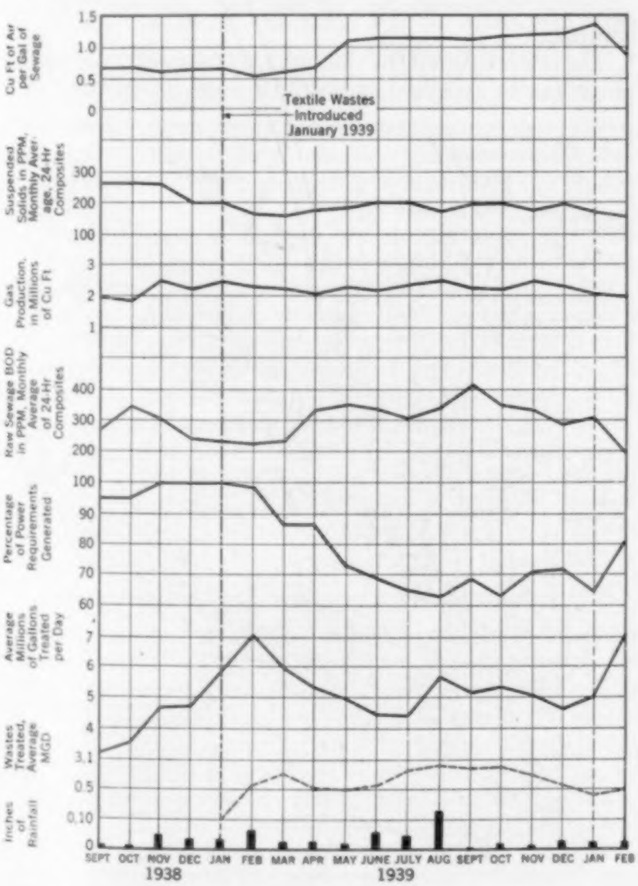


FIG. 2. OPERATION DATA, NORTH BUFFALO PLANT, FOR SEVENTEEN MONTHS, 1938–1940

DETAILS OF PLANT—IN FOREGROUND, DISCHARGE FROM ONE DETRITOR; ACROSS ROAD, FLOCCULATORS IN RECTANGULAR TANKS

June is due to power costs in the period when kier liquor was entering the plant in large quantities. In January, no wastes of any consequence were treated. The cost of treating combined wastes over a period of eleven months averaged $18.54 per million gal, with a high of $24.71 in June. These figures do not include fixed charges.

Of the total domestic sewage operating cost, the distribution as between different operations is:

Wages	40.0%	Repairs and maintenance	9.7%
Power	22.8%	Chemicals, supplies, etc.	27.5%

EXPERIENCE TEACHES LESSONS

It would be dangerous to draw any hard-and-fast conclusions concerning the handling of textile wastes mixed with domestic sewage, after so short a period of operation. However, from the experience at the North Buffalo plant the following suggestions are made:

1. Accepted bases of design for flocculation and secondary sedimentation seem to hold good for mixed wastes as well as for domestic waste only. There are indications that detention time in primary basins should be increased approximately 50%.

2. Provision for air, if the activated sludge process is utilized, should be increased to a probable maximum of 2 cu ft of air per gallon of sewage at rated flow capacity. Indications are that detention time usually provided in aeration basins is sufficient.

3. Digester capacity should undoubtedly be increased at least 50% over the standard 2 cu ft per capita.

4. Provision should be made for thickening of the excess activated sludge before it is pumped or otherwise transported to the digesters.

5. Considerable study should be given to practical provisions for the conditioning of return activated sludge.

6. Provision should be made for positive pH control before the sewage enters the plant. A flexible system of chemical application is also a definite requirement.

7. Under most favorable operating conditions, the use of alum, iron salts, or other chemicals brings about maintenance difficulties due to corrosion. Likewise the use of gas from the digesters for power seems to be the cause of heavy maintenance costs on engine auxiliaries and heating units. It is therefore imperative that equipment and processes be as simply designed as possible.

8. Only personnel of the highest type should be charged with the operation of a plant such as has been described. In its operators there should be combined the ability to carry on routine work and the desire to inquire into the "whys and wherefors."

9. From the city's standpoint, the voluntary and active cooperation of the mill interests is vital. While many parts of the Greensboro operation might not be applicable to the solution of problems of other cities, the close cooperation between the municipality and the waste-contributing unit is highly desirable.

10. Finally, I feel that the problem calls for continued research, the keeping of accurate records on existing installations, and a real desire on the part of the contributing parties to solve the problem.

Laboratory, Garage, and Office Building, Belgrave Sewer District, New York
Typical of Attractive Treatment of Newer Plants

Pollution Abatement in New York Area—Interstate Problems

By Seth G. Hess

Member American Society of Civil Engineers
Chief Engineer, Interstate Sanitation Commission, New York, N.Y.

Wherever great numbers of people congregate, as in and around New York City, sewage disposal becomes a serious problem. Out of many studies for this area by eminent authorities and civic commissions, finally emerged the Interstate Sanitation District. Its method of coping with pollution, its success to date, and its plans for the future are here recounted. This paper, originally delivered before the Sanitary Engineering Division at the Society's 1940 Annual Meeting, will be followed by others on related topics.

In common with municipalities from the time of ancient Jerusalem and Rome in its glory, New York City has its problems of sewage disposal. It has always had them, in spite of the fact that it is ideally situated for disposal by dilution.

Today some may question the judgment of earlier engineers, when they carried combined sewers by the shortest route to the waterways adjacent to all of the metropolitan area. But in 1850, when the comprehensive design was prepared for Brooklyn, the population within the present boundaries of greater New York was only 869,000. Congested populations of seven to ten millions were not even considered at that time. Small wonder then that little or no consideration was given to a program of sewage disposal beyond what would meet immediate needs.

Apparently, sewage was permitted to flow into the surrounding waters with little or no concern until early in the twentieth century. Then, with the population almost three and a half million, of which 1,850,000 were on Manhattan Island, there was a sudden realization of the condition of the waters in this district. In succession came investigations by Burr, Hering, and Freeman, by Breitzke, by Hazen and Whipple, by the Metropolitan Sewerage Commission, by the "Sewer Plan Commission," and by Allen.

A Joint Legislative Committee formed to devise ways and means of abating pollution in waters of common interest to New Jersey, New York, and Connecticut, submitted a report in February 1927. The U.S. Engineer Office had made a report in 1925 concerning the pollution of the Hudson River up to Poughkeepsie. Other reports and studies included those of the Governor's Special Long Island Sanitary Commission of May 1931, and the Nassau County Sanitation Commission, which presented its report in December 1935. These reports disclose the vast amount of study that has been given to the problem of abatement of pollution in New York Harbor and adjacent waters. An extended bibliography has been filed in the Engineering Societies Library in New York.

At the turn of the century, there were practically no sewage treatment plants in the metropolitan area; ten years ago, however, there were 35, of which 10 merely provided mechanical screening. Within the past ten years the problem of abatement of pollution began to be approached on a more comprehensive basis, giving consideration to a general coordinated plan. The City of New York began a construction program, based upon a tentative general plan. In 1932, the final report of the Tri-State Treaty Commission recognized the need for establishing uniform standards of minimum treatment to be given all pollution entering what later became known as the Interstate Sanitation District. That Commission, through its Research and Engineering Committee, recognized that no single standard of purity was practicable in all parts of the treaty area, and therefore recommended one set of standards for the treatment of all pollution entering areas expected to be used primarily for recreational purposes, shellfish culture, and the development of fish life; and another for pollution discharged into waters not expected to be so used. These standards established physical and bacteriological limits to be met by all pollution entering the area. In addition, chemical standards were established referring to the waters of the District rather than to the pollution itself, and even in this case the analyses are made of samples from the general vicinity of the point of discharge of the sewage into the waters of the District.

The recommendations of the Tri-State Commission were eventually enacted into law, as a result of which the Interstate Sanitation Commission came into being early in 1936, with authority to bring legal action in its own name against any municipality or other entity violating the provisions of the law and the interstate compact.

The laws required the Commission to classify the District according to expected predominant use, designating water

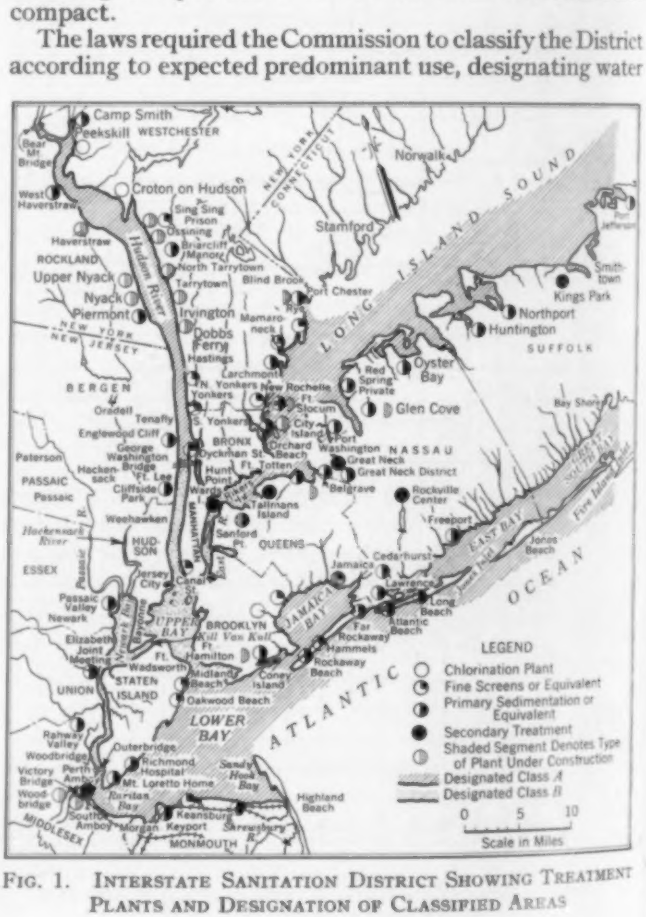


Fig. 1. Interstate Sanitation District Showing Treatment Plants and Designation of Classified Areas

areas to be used for recreational purposes, shellfish culture, and the development of fish life, as Class A (Fig. 1), for which sewage must be so treated as (*a*) to remove all floating solids and at least 60% of the suspended solids; and (*b*) to effect a reduction of organisms of the B. coli group, so that the probable number of such organisms shall not exceed 1 per cc in more than 50% of the samples of sewage effluent tested by the partially confirmed test, provided, however, that in the case of discharge into waters used primarily for bathing, this bacterial standard need not be required except during the bathing season; and (*c*) to maintain an average dissolved oxygen content in the tidal waters of the District in the general vicinity of the point of discharge of the sewage at a depth of about 5 ft below the surface, of not less than 50% saturation during any week of the year.

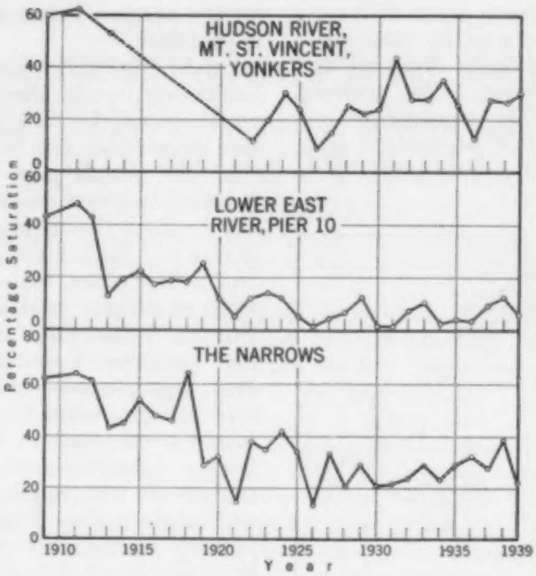


FIG. 2. VARIATION IN DISSOLVED OXYGEN AT THREE TYPICAL POINTS IN METROPOLITAN AREA

Other waters are designated Class B (Fig. 1), and all sewage permitted to flow into them is required to be so treated as (*a*) to remove all floating solids and at least 10% of the suspended solids, or such additional percentage as necessary to avoid forming sludge deposits in the Class B waters of the district; and (*b*) to maintain an average dissolved oxygen content in the general vicinity of the point of discharge of not less than 30% saturation during any week of the year. Classification of the area is shown on the map, Fig. 1. Great progress has been made in constructing sewage treatment works for the abatement of pollution in this area in the past decade. The results are also shown on the map. More details are given in a complete list on file in the Engineering Societies Library. There are now 53 treatment plants in operation, and 17 new plants or additions under construction.

Although specific figures are not readily available, the total amount of dry solids removed by treatment in the Interstate Sanitation District in 1930 is estimated at 21,250 tons per annum. Our estimate of the suspended solids entering the District today is 432,000 tons yearly, of which 106,700 tons are removed by treatment, or approximately five times that removed a decade ago. If the pollution load is measured by biochemical oxygen demand, the total estimated demand before treatment is 2,044,000 lb per day. Of this, 252,000 lb are being removed by treatment daily, and there remains an estimated load upon the waters of the District of 1,792,000 lb per day.

CURVES FOR DISSOLVED OXYGEN SATURATION

Characteristic trends in minimum dissolved oxygen saturation in the District are shown in Fig. 2. The dissolved oxygen in the Hudson River, at Yonkers, just north of the confluence with the Harlem River, shows improved conditions this year. This condition, like a similar one in the upper East River (not shown), is not surprising because of the influence of the Wards Island Sewage Treatment Works. Interception of the sewers along the Harlem River now permits a flow of comparatively clean water to be carried from Long Island Sound through the Harlem River into the Hudson.

The remaining curves of Fig. 2 are discouraging at first glance, as they all show a diminution of dissolved oxygen in the past year. If this condition is attributed to the abnormally low rainfall and runoff a considerable amount of controversy would result, since there are many who believe that low runoffs permit greater amounts of clean water to enter from the ocean on the incoming tides, thereby reducing the pollution in the harbor. Another school of thought claims that there is a reduction in the dilution from the Hudson River, and that the additional dilution from the ocean merely causes a shuttling back and forth of polluted waters, which would otherwise be driven out by greater flows from the Hudson River.

Tidal current charts of New York harbor indicate that under the most favorable conditions, it would take from 4 to 5 hours for the effluent from Wards Island to reach the Narrows. These computations are confirmed by a series of float tests taken 1907–1909. Furthermore, a review of the curves (Fig. 3) showing dissolved oxygen saturation at the Narrows, which were plotted with respect to the time of the observation relative to tide, indicates that the minimum dissolved oxygen observations occurred approximately 2 hours after low water at the point of observation. The improved conditions resulting from the treatment of sewage from the northeasterly portion of Manhattan and from the Bronx have not yet shown any direct or appreciable effect on the dissolved oxygen observations at the Narrows.

However, conditions in the vicinity of Prince's Bay, Staten Island, give concrete evidence of improvement. Treatment works in the contributory area have been instrumental in improving conditions to such an extent that state and city authorities have approved certain sections of that area for the direct taking and marketing of hard clams. The sections thus opened had been closed since 1924.

ESTIMATING THE COST OF NEEDED TREATMENT

As to the cost of construction of treatment works to meet the requirements of the Interstate Compact, this problem must necessarily involve not merely the cost of the treatment plants, but frequently the cost of interceptors to convey the sewage from multiple outlets to a central point of treatment. Fortunately, plans and estimates have already been made for many of the municipalities within the District. However, estimating the cost of such a huge project is very difficult and cannot be done with absolute accuracy. The focal points of population within the District change very rapidly. Manhattan Island, for instance, has apparently passed its peak of population and already the trend appears to be toward decentralization.

Within 25 to 30 years undoubtedly some existing plants will have become overloaded and others will be required where at present the need for them is not anticipated. The ultimate cost of sewage treatment in this area could be accurately determined beforehand only if there were a considerable degree of stability of population, not merely in numbers but also in location.

By assembling available data for some areas with estimates for other areas, the additional cost for treatment works required to provide for pollution entering the Interstate Sanitation District is found to be between \$200,000,000 and \$250,000,000. This expenditure will provide treatment works to serve the population anticipated in the near future, but will not be sufficient to finance the ultimate costs for this area.

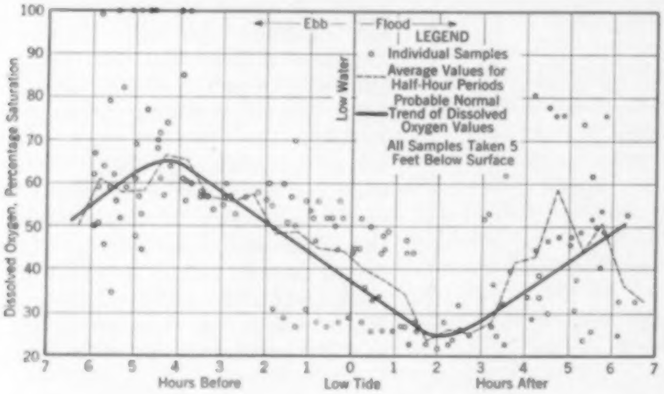


FIG. 3. CYCLE OF DISSOLVED OXYGEN SATURATION WITH THE TIDES AT THE NARROWS

Steps have been taken that will lead to compliance with established standards in a considerable portion of the area draining directly into the Interstate Sanitation District. Some areas remain without such provisions, and we are faced with the question of programs for these areas.

Public opinion is becoming more and more conscious of the need for sewage treatment works for the abatement of pollution. The instinctive disgust called forth by unpleasant conditions is nature's way of warning us against conditions that are dangerous. This warning should not be disregarded.

Now what program of sewage abatement can be undertaken by the Interstate Sanitation District, either as a huge joint project under the direction of a single authority, or under the present setup, whereby individual municipalities or voluntary groups of municipalities construct plants to comply with the established standards?

THE PROBLEM OF FINANCING NEEDED CONSTRUCTION

With the recognized need for abatement of pollution and with the support of public opinion, there still remains one great difficulty. The depression, the construction of other more attractive public works, and high taxes make the problem of financing the construction of sewage-treatment works an outstanding obstacle. The mere issuance of orders that sewage-treatment works be constructed is not the complete solution of the problem. Where municipalities are financially able to undertake such works, orders of this nature may be sufficient. Where funds are not available, the financial situation must be faced before a program can be offered.

This situation can be met in several ways. One would be to establish a capital outlay budget for a municipality to provide for the limitation of construction of other more attractive public works so that the more necessary, though possibly less glamorous works, could be constructed within a reasonable time. Such a program is being undertaken at the present time within the Interstate Sanitation District. Municipalities unable to proceed at this time with construction of sewage-treatment works are working on a capital outlay budget which will permit such construction within a reasonable time and provide for the necessary finances when construction is actually undertaken.

Again, assistance may be offered by the District in marketing bonds, the interest and the amortization for which would be met by sewer rentals. When offering this suggestion, one is always faced with the argument that the people pay for the improvements, either by taxation or sewer rentals, and therefore the sewer rentals are no more desirable as a method of raising funds than taxation. Such an argument is not entirely convincing. In the first place, real-estate taxes are extremely burdensome at present, and any addition thereto arouses opposition. Apparently, much of the burden is being carried by present real-estate taxes. Sewer rental, however, is in the same category as other utility charges. It represents a charge for services rendered, and is accepted in the same category as charges for water, gas, or electricity. Furthermore, records of collections for sewer rentals are very much more favorable than collections of real-estate taxes. Finally, by this method, payments are applied to the cost of the improvement, and there is little likelihood of diverting the funds so collected to other purposes.

A third means may be considered an incentive to solve, if not a solution for, the financial problem. Federal grants in aid have been an outstanding impetus for the construction of works for the abatement of pollution. Through the Federal Public Works Administration and Works Projects Administration, the program for the abatement of pollution not only in the Interstate Sanitation District but throughout the United States has moved forward at a pace never before attained. However, some municipalities within the District are in such a financial condition that they cannot avail themselves of federal aid.

Federal and state aid for the construction of sewage works has been considered in numerous bills. Such grants-in-aid, either federal or state, have an underlying soundness. Pollution has no respect for man-made boundaries. It moves readily from one state to another and from one municipal shore front to another. The construction of a sewage-treatment plant may present benefits to an adjacent municipality as well as to the municipality in which the plant is situated. Such works therefore benefit not one municipality but many both in the state and in the nation, to as great an extent as the distribution of benefits from federal and state roads, education, and waterways.

The program for abatement of pollution in the Interstate Sanitation District may be summarized as follows:

1. The degree of treatment has been established for all sewage or other polluting matter entering the waters of the District.
2. A commission has been charged with the duty and the authority to enforce the requirements of the Interstate Sanitation Compact.
3. Public opinion is becoming awakened to the problem, and recognizes both the need and the desirability of conforming with the sanitary standards established.
4. The program is being undertaken at present by the action of individual municipalities or groups of municipalities to meet established standards.
5. Financing the construction of works is one of the major problems.
6. Federal or state "grants-in-aid" are salutary incentives to the construction of sewage-treatment works.
7. If the present rate of construction is maintained, the program will overtake current requirements within ten years.

An Engineer Looks at the TVA

Acute Social and Economic Problems Being Solved by Application of Technical Principles and Methods

By J. W. Bradner, Jr.

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Manager, Norris Properties, Tennessee Valley Authority, Norris, Tenn.

In the congressional legislation that created the TVA in 1933, it was expressly stated that the general welfare of the people was to be provided for. Here was a complicated problem, even apart from matters of dam construction and power output. This great valley with its vast natural resources, healthful climate, potentially fertile land, water in abundance, and a fine type of citizenry, was plagued by floods in spring and low water in summer, was rapidly losing its valuable topsoil, and was noteworthy for its poverty of opportunity and the low-income status of its people. Mr. Bradner here explains how the Authority accepted this challenge, how it conducted the most meticulous research and attacked basic economic problems through cooperation with the people themselves—giving them help and hope in the practical business of daily living.

As a professional group we engineers must more and more turn our thoughts to the human results of our work. Why do we build a road, a bridge, a railroad? We always labor to serve the people in some manner, and to minister to their wants. Now if we are concerned about the "why" of all this activity in the Tennessee Valley, we must look further than concrete and steel. We must find out something about the land and the people.

Although most of us long since learned to have some doubts as to the complete efficacy of the statistical method, we must consider some statistical information before we can define the problem. The Tennessee Valley covers an area of 41,000 sq miles, including parts of seven states, and varying in climate from temperate to almost subtropical. One of the distinguishing physical characteristics of the area is its rainfall. The seven Valley states include 40% of the total area in the United States having an average annual precipitation of 40 in. or more, and 54% of the total area having 50 in. or more. The entire Tennessee Valley is included in the 40-in. rainfall area, and more than two-thirds in the 50-in. zone. A distinguishing characteristic is the seasonal character of this rainfall.

Of the 26,000,000 acres comprising the watershed, about 18,000,000 are in farms, of which about one-third is in farm woodlands, pasture, and cultivated crops, respectively. Practically all the remainder—roughly 8,000,000 acres—is in forest. According to data collected by the Tennessee Agricultural Experiment Station, only about 20 per cent of the area is not undergoing erosion; 35% has lost almost half of its topsoil; 42% has lost two-thirds or more of its topsoil; and 3% has been destroyed for agricultural use.

For many years one of the chief farm crops in the Valley has been cotton. While a certain amount of corn, wheat, tobacco, and livestock has been produced, a large percentage of these has been imported from other sections. As an interesting sidelight on the economics of farming consider that in 1935 the average person engaged in agriculture in Tennessee derived a net income of $406 per year, while in Ohio he was receiving a net income of $1,102.

Industrial development in the Valley has been very slow, as indicated by the fact that in 1937, the total value of finished products in Tennessee was only $707,986,784, while for the same year in Ohio it was $5,099,816,893.

Now what do we know of the people in the Tennessee Valley that would help us to define our problem and plan our attack? Although there are only 2,500,000 people in the Valley itself, there are more than 17,000,000 in the seven Valley states. Three-fourths of the people in the Valley make their living from agriculture, while in the country as a whole 24% are so engaged. Per capita income in the Tennessee Valley in 1930 was $291, as compared with $595 for Ohio, and $587 for the whole United States. On a percentage-of-income basis the Valley inhabitant was paying as much for education as other citizens of the country, but educational expenditures per child enrolled in school were less than half the national average.

Top of an Electric Furnace in a Nitrate Plant at Muscle Shoals
A Part of This Plant Has Been Adapted for the Experimental Production of High-Analysis Phosphatic Fertilizer

We also find that despite the high birth rate (50% higher than in the country as a whole) and the average death rate, the population of the Tennessee Valley is not increasing. In the ten years from 1920 to 1930, over a million people over ten years of age migrated from the Valley to other sections of the United States. It is worth observing that this loss of population has been a terrific economic drain on the region.

There are many reasons why income is low in the Tennessee Valley. A large part of the area was settled by planters from Virginia and South Carolina, who brought with them the traditions of a plantation economy. Their principal crop was cotton for export, and while cotton has been the life blood of this region and has been largely responsible for our emergence as a world power, it and the plantation

TERRACING HELPS TO HOLD THE FERTILE TOPSOIL, CONTROL FLOODS, AND REDUCE SILTING OF STREAMS

A Pasture in London County, East Tennessee

system have contributed to many of the ills of the area. The South lost much of its capital, which was land and slaves, as a result of the Civil War. In addition the violent economic changes resulted in the establishment of the share-cropper system, under which the fertility of the soil has steadily declined. Although cotton has continued as the chief export of the United States, since the World War exports and prices have steadily dropped. Thus the cotton farmer has been faced with a glutted market, low prices, and land diminishing in fertility.

Another element of the problem was the freight-rate structure that penalized the Southern shipper of manufactured goods. A final element, whose importance can hardly be accurately appraised, is absentee ownership of large quantities of natural resources, so that the Southeast, instead of accumulating capital to replace that lost in the Civil War, has seen the profits it created drained to the North and East.

With this admittedly sketchy background, we may define our problem briefly as follows. Here is an area with vast natural resources, a healthful climate, potentially valuable forests, acres of potentially fertile land, numbers of commercially valuable minerals, water in abundance, a fine race of people; but an area characterized by low income and little opportunity, plagued by floods in the spring and low water in the summer, an area losing its population increase by the hundreds of thousands, an area losing its soil.

Now what plan of attack was suggested? On April 10, 1933, President Roosevelt proposed that Congress create a Tennessee Valley Authority, a corporation clothed with the power of government but possessed of the flexibility and initiative of a private enterprise. In line with the President's proposal, the TVA was created by Congress in 1933. The legislation under which it operates contemplated not only the integrated control of the Tennessee River and its tributaries, but the use of this control to accomplish a number of objectives. In addition to the aims of navigation, flood control, agricultural and industrial development, and the national defense, the legislation directed the Authority to make demonstrations and surveys looking toward legislation that would further the proper use, conservation, and development of the natural resources of the drainage basin and adjoining territory materially affected by the development, and to provide for the general welfare of the citizens. This legislation also authorized the development of electric power and the transmission and sale of such of it as might not be needed for government purposes. It is significant that the entire development was directed toward the general welfare of the people.

Before proceeding with a description of the work of the TVA, it seems important that we understand just how this agency operates. While a part of the federal government, it is locally administered, and within the framework of national policies is responsive to the desires and wishes of the people most directly affected by its work. This matter of administration is one of the most important aspects of the entire program.

Before it began any important work, the Authority had to make a number of basic decisions. One of the important early ones was that it would do its own engineering and construction; another was that the same wholesale power rate would apply wherever it sold power.

Another important early decision had to do with fertilizer experimentation. The plants at Muscle Shoals had originally been designed to manufacture nitrates for explosives in wartime, and it was anticipated that they might be used to make fertilizer in peacetime. The legislation creating the TVA specifically authorized their adaptation to improve and cheapen fertilizer production.

Plants require a dozen or more nutrient elements for their normal growth and development, but with the exception of nitrogen, phosphorus, potassium, and calcium, these elements are present in most soils or in air and water in sufficient quantities for plant needs. TVA officials, in consultation with state and federal agricultural authorities, considered the possibility of working with these four needed plant nutrients. In spite of the inheritance of a nitrate plant, they decided against nitrogen, because most farmers should get the bulk of their nitrogen out of the air, with legumes. The decision went against potassium also, as there are many times as much potassium in the soil as phosphorus or even nitrogen. Moreover, it is produced at several mines in this country. Lime never posed a problem. It is needed greatly as a conditioner for acid soils, but it can be applied effectively as ground limestone, a common rock.

Phosphorus remained. Most soils need it. With lime, it is recognized as the key to a lasting agriculture, for phosphate and lime make legumes grow and legumes take nitrogen out of the air. Thus a pound of phosphorus may be responsible for the fixation of six pounds of nitrogen. At present phosphate mining operations are practically confined to Florida and Tennessee, where about one-third of the world's output is produced. Most of our known phosphate deposits, perhaps 95%, are in publicly owned lands in Utah, Wyoming, Montana, and Idaho—beyond the reach of the great majority of American farmers under present systems of processing.

TVA RESEARCH DEVELOPED A REFINING PROCESS FOR NORTH CAROLINA KAOLINS

Ceramic Laboratory, Where This View Was Taken, Is Now Operated by the U.S. Bureau of Mines

Ordinary phosphate fertilizer contains such a relatively small percentage of available plant food that bagging, freight, and handling charges make its cost on the land so high that the farmer has been unable to buy as much as he needs. Since phosphate is necessary to the successful growing of legumes, this meant that the farmer was also unable to secure a sufficient quantity of nitrates.

For these reasons the TVA Board of Directors decided that it could render no greater service to the land and the people than by carrying on research looking toward the production of more concentrated and cheaper phosphate and toward the economical and effective application of such products to the land under practical farming conditions.

PHOSPHATE MANUFACTURE AT MUSCLE SHOALS

The processes that have been improved and developed at Muscle Shoals for the production of phosphates involve detailed achievements in chemistry and engineering. These developments, which are covered by more than three dozen patents, go through three stages—a laboratory stage; a pilot plant stage, in which sufficient quantities of new materials are produced for tests by experiment stations under controlled conditions; and a commercial-sized stage, in which products that have proved themselves by experiment station tests are produced in full-sized equipment and tried out to determine how they can be fitted into actual farming systems.

Two processes for making phosphatic fertilizer are being operated in the last stage of development. One produces a material that contains 45% of available plant food, and the other a product containing 65%. The latter is more concentrated than any phosphate hitherto used by farmers. The commonly used product contains 16% phosphate.

The U.S. Department of Agriculture and state agricultural colleges have taken up the testing of TVA experimental fertilizers in 46 of the 48 states. In 20 of these, organizations of farmers are carrying on practical farm test-demonstrations with Extension Service guidance. There are more than 27,000 such test-demonstration farms, covering 4,500,000 acres. With the guidance of county agents, the demonstration farmers lay out a five-year program to revise their farming in the interest of soil and water conservation. The Authority supplies, f.o.b. Muscle Shoals, the phosphate needed for

FARMERS—BOTH MEN AND WOMEN—MEET TO DISCUSS MUTUAL PROBLEMS

This Regular Monthly Gathering in Wheat Community, Roane County, Tenn., Typifies the Cooperative and Inquiring Spirit That Is Improving Farming Methods and Conditions in the Valley

the changes, while the farmers pay all other costs. This phosphate is applied only to water and soil-holding sod crops, not to erosion-producing row crops such as corn, cotton, and tobacco.

As a result of the cooperative efforts of the CCC, the TVA, and individual farmers, approximately 100,000,000 trees have been planted on some 70,000 acres of badly eroded land, abandoned for agriculture, while an additional 30,000 acres have received erosion-control treatment without tree planting. Cooperative agreements on forest-fire control measures are also being consummated.

In cooperation with local and federal planning agencies, the Authority has helped in formulating progressive legislation adopted by the Valley states, and has worked with the Bureau of Public Roads and the states in long-range highway planning. Social and economic consequences of land purchases, dam and reservoir construction, cheap power, and other of the related activities of the Authority that have an effect on people, have been studied.

Interesting work also has been done in investigating and promoting the wider and better use of electric power for agriculture, and in demonstrating its use for smaller local industries. Kaolins of various types have long been used for coarse pottery in the Tennessee Valley, but the American kaolins have been neglected for fine dinnerware, because no effective refining method was known for them. Having an interest in promoting the wider use of these local materials, so as to build a base for increased purchasing power in the region and to open a direct market for electricity in the manufacture of fine porcelain, the Authority established a ceramic laboratory at Norris. This laboratory, over a period of three years, worked out a refining process for American kaolins. It has also been successful in the development of new techniques in manufacture, and it seems certain that the processes developed will cause the American kaolins to be substituted for the English ones now imported. As a result, two modern commercial refineries have been built by private companies and are processing the domestic kaolin.

The use of the electric furnace to produce temperatures above the melting point of metallic alloys is new in America, and the laboratory has had to develop special methods and materials. The results have aroused a keen interest among executives and engineers in the electric manufacturing field. The laboratory now is operated by the Bureau of Mines, which is studying

A WELL-EQUIPPED CABIN IN NORRIS PARK

This 3,800-Acre Recreation Area near Norris Dam, Developed by National Park Service and CCC in Cooperation with TVA, Counts Boating and Horseback Riding Among Its Attractions

the processing of other non-metallic and metallic minerals.

A great amount of other research has been done, largely in cooperation with the Valley agricultural experiment stations and engineering colleges. This cooperative policy has resulted in many times multiplying the amount of work that it has been possible to do in so short a time. Developments resulting from this research constitute an integral part of the Authority's major activities. It has been shown that the fall grain and lespedeza cropping system is an important means whereby private landowners can carry out their part of the soil and water conservation program. Under this system, savings of 50 to 100 lb of nitrogen per acre are obtained, plus a cash income of $15 to $20 per acre for the grain. But no suitable low-cost equipment has been on the market to plant fall grains in hard lespedeza soil on hillside land. The Authority has designed and developed a hillside seed and fertilizer distributor which permits the small farmer to seed fall grain in alternate strips on legume or grass sod. This distributor is now being produced by a Southern manufacturer, priced at less than $25.

ELECTRICITY COMES TO RURAL MISSISSIPPI
A Farm Home near Dennis, Miss., After the Installation of Modern Electrical Equipment Caused the Farmer to Take New Pride in His Home and Repair and Paint It

OTHER LITTLE-KNOWN ACTIVITIES OF THE AUTHORITY

The Authority, in cooperation with state colleges, has developed an electric hay dryer that should cost from $300 to $400, which is many times less the cost of the large commercial dryers. Threshers, feed grinders, and seed harvesting attachments for mowing machines also have been developed. Machinery and processes have been developed and installed in four cotton-seed-oil extracting mills which, if installed in all mills, would add $3,000,000 per year to the value of the nation's cotton crop. The Authority has also, in cooperation with the Tennessee Engineering Experiment Station, done considerable work in the field of quick-freezing of small fruits and vegetables. Other experiments have been carried on in the fields of rural refrigeration, electrical soil heating, development of small brooders, and of many other devices that can be used by the small farmer.

One of the most significant opportunities for the Authority to contribute toward the economic improvement of the Valley's inhabitants occurred in relocating families whose property was affected by TVA reservoirs. During the process of removal, the Authority enlists the aid of local agencies in an attempt to improve the economic condition of these people by helping them to relocate on comparable or better lands.

Another of the little-known activities of the Authority has been the construction, through cooperation with the CCC and the National Park Service, of two demonstration parks on the shore of Norris Lake. Out of the Authority's experience with these have come relationships resulting in the construction of several other state parks, by the National Park Service, to be operated by the states.

Still another interesting development, which has resulted from the Authority's construction program, has been the formulation and adoption of an employee relationship policy. This policy, growing out of conferences between management and employee representatives, recognizes the rights of the employees to organize, affiliate as they choose, designate representatives, and bargain collectively with the management of the Authority. Grievances can be brought to light and examined fairly, and provision is made for conferences between management and representatives of the employees whereby major policies affecting employees may be decided upon. To date the policy has proved extremely valuable, not only in eliminating misunderstandings, but in securing a degree of employee morale that is seldom evident in any large-scale undertaking.

It may well be asked at this point just how far the Authority has progressed toward accomplishing the results hoped for by the President when it was created. I believe it is only fair to state that many of the objectives are of such a nature that any short-term appraisal would be unfair. Nevertheless, there has been definite progress.

As regards flood control and navigation, while the system of dams and reservoirs is only half completed, benefits of considerable magnitude have already resulted. As regards power marketing, the Authority is well able to dispose of all the power it can generate. Furthermore, as a result of the Authority's program in this field, retail power rates in the Tennessee Valley have been reduced 44%.

In developing concentrated forms of phosphatic fertilizer the Authority is focusing attention upon the savings inherent in such high-analysis materials and upon the need for greater use of phosphate if our agriculture is to be permanent. Farmers are instituting important changes in their farming as a part of the testing and demonstrating work. There is more liming, more terracing; more protection of sloping land with sod, especially leguminous sod crops; more production of feed and food at home; and altogether a better balance between livestock and cropping. Such basic improvements are built upon and continue the long-time work of federal and state agencies for agricultural betterment.

An incidental result of the TVA program that may have far-reaching effects is recreation. The creation of a broad chain of lakes through this picturesque country is certain to add substantially to the social and economic development of the area.

Now I have tried to show the TVA as I, an engineer, see it. It is an agency trying to solve through its works the problem of low income and lack of opportunity in the Tennessee Valley. It seems evident to me, even at this early date, that its efforts are meeting with success. Furthermore, it seems perfectly obvious that any success it may have in this section of the country will result in good for other sections and, in fact, for the country as a whole. In addition—and I feel that this is of utmost importance—in this day of dictatorships and expressed doubts as to the survival of our democratic form of government, I sincerely believe that the work of the Authority to date is living proof that we can analyze our problems, and plan and execute our attacks, in an orderly, economical, and efficient manner, within the framework of democracy.

The Source of Water Derived from Wells

Essential Factors Controlling the Response of an Aquifer to Development

From a Paper Presented Before the Arizona Section

By Charles V. Theis

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Continued increase in the use of ground water for municipal and industrial purposes, and for irrigation, makes more pressing the question as to the extent of reserves of ground water and the advisability and methods of regulating its use. Proper regulation, of course, is conditioned upon the ability to forecast with some degree of accuracy the future history of water levels in wells in a given area. Mr. Theis here gives a clear picture of the factors that must be taken into account in such forecasts, and concludes with a brief summary of recommendations for "the ideal development of any aquifer from the standpoint of maximum utilization of the supply."

This paper discusses in a general way the essential factors that control the response of an aquifer to development by wells. A knowledge of these factors, including the role of time, is necessary for the interpretation of existing records of water levels, and can yield the only method of predicting the effect of ground-water development in an area where records of long duration are lacking. Some of these factors have been long recognized but others have come to light in the last few years, and the intensive work now being done in quantitative ground-water hydrology will doubtless still further refine our concepts.

The essential factors controlling the action of an aquifer appear to be (1) the distance to, and character of, the recharge; (2) the distance to the locality of natural discharge; and (3) the character of the cone of depression in the given aquifer. Figure 1 illustrates diagrammatically the controlling factors in one type of aquifer.

Conditions of Equilibrium in an Aquifer

All ground water of economic importance is in process of movement through a porous rock stratum from a place of intake or recharge to a place of disposal. Velocities of a few tens or a few hundreds of feet a year are probably those most commonly met with in aquifers not affected by wells. This movement has been going on through a part of geologic time. It is evident that on the average the rate of discharge from the aquifer during recent geologic time has been equal to the rate of input into it. Comparatively small changes in the quantity of water in the aquifer, with accompanying changes in water level, may occur as the result of temporary unbalance between discharge by natural processes and recharge, but such fluctuations balance each other over a complete season or climatic cycle. Under natural conditions, therefore, previous to development by wells, aquifers are in a state of approximate dynamic equilibrium. Discharge by wells is thus a new discharge superimposed upon a previously stable system, and it must be balanced by an increase in the recharge of the aquifer, or by a decrease in the old natural discharge, or by loss of storage in the aquifer, or by a combination of these.

Conditions in the Recharge Area

Recharge to the aquifer may result from the penetration of rainfall through the soil to the water table, or by seepage from streams or other bodies of surface water, or by movement vertically or laterally from another ground-water body. The latter process is more or less an incident in the movement of water underground, and will not be discussed here. Two possible conditions in the recharge area must be considered. The potential recharge rate may be so large in wet seasons or cycles, or even uniformly, as to exceed the rate at which water can flow laterally through the aquifer. In this case the aquifer becomes over-full and available recharge is rejected. The water table stands at or near the surface in the recharge area. There may be permanent or seasonal springs in low places discharging the excess water, or there may be marshes or other areas of vegetation drawing water from the zone of saturation and transpiring the excess. In such a case, it is evident that if use of ground water by means of wells can increase the rate of underground flow from the area, more water is available to replenish the flow. More water will go underground and the springs will flow less, or through-flowing streams will lose more water, or the vegetation will become more sparse.

On the other hand the possible rate of recharge may be less than the rate at which the aquifer can carry the water away. The rate of recharge in this case is governed (1) by the rate at which the water is made available by precipitation or by the flow of streams, or (2) by the rate at which water can move vertically downward through the soil to the water table and thus escape evaporation. In recharge areas of this latter type, none of the recharge is rejected by the aquifer.

In attempting to determine where the water discharged by wells comes from, or, more accurately, what process

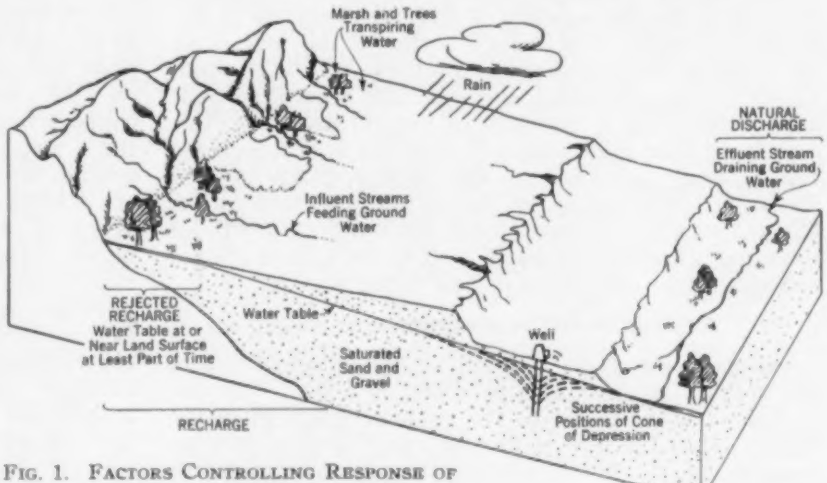

Fig. 1. Factors Controlling Response of an Aquifer to Discharge by Wells

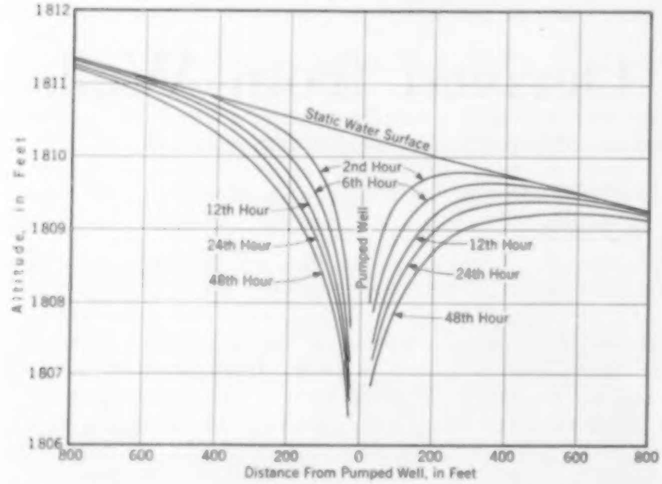

FIG. 2. GROWTH OF CONE OF DEPRESSION DURING PUMPING TEST IN PLATTE VALLEY, NEBR.

(After L. K. Wenzel, "The Thiem Method for Determining Permeability of Water-Bearing Materials," U.S. Geological Survey Water Supply Paper 679-A, Fig. 6, p. 39, 1936)

serves to balance the hydraulic system after the new discharge of the wells is imposed on it, this difference between rejected recharge and unrejected recharge must be kept clearly in mind. If water is rejected by the aquifer in the recharge area under natural conditions, then pumping of wells may draw more water into the aquifer. On the other hand, no matter how great the normal recharge, if under natural conditions none of it was rejected by the aquifer, then there is no possibility of balancing the well discharge by increased recharge, except by the use of artificial processes such as water spreading.

Figure 1 indicates diagrammatically the difference between these two conditions. Near the mountain border the water table is close to the surface, there is vegetation using ground water, and streams maintain their courses. This is the area of rejected recharge. A lowering of the water table in this zone will result in adding to the ground-water flow by decreasing the amount of transpiration and surface-water runoff. In the remainder of the area there is some recharge by rainfall, but the water table is so deep that no comparatively small change in its level can affect the amount of recharge. No recharge is rejected here and no lowering of the water table by pumping will cause more water to seep downward to the ground-water body.

The normal recharge of the aquifer is sometimes assumed to be the measure of the possible yield of the aquifer to wells. The theory is that if the wells take the recharge, then the natural discharge will be stopped. Under certain conditions, and especially where the wells are located close to the area of natural discharge, this may be at least approximately true, but it is recognized that generally wells are not able to stop all the natural discharge. Whether or not the natural discharge can be affected, or whether the recharge can be affected without too great a lowering of water level in the pumping area, depends on the conditions of flow in the aquifer.

CONDITIONS OF FLOW IN THE AQUIFER

Ground water flows through an aquifer according to the simple law enunciated by Darcy in 1856. The rate of flow is proportional to the pressure gradient in the water. Thus the flow of ground water bears a close resemblance to the flow of heat by conduction in a solid, or the flow of electricity through solid conductors.

Under Darcy's law there is only one way of reducing the flow in the areas of natural discharge or of increasing the flow in the areas of recharge. This is by changing the pressure gradient or the thickness of saturation of the aquifer in those areas, which in turn means changing the height to which water levels rise in wells throughout the area between the producing wells and the areas of natural recharge or discharge. This means a lowering of water level everywhere between the wells and the areas of natural discharge or recharge. In turn this means a reduction of storage in the aquifer and an abstraction of water from it.

There are two fundamental physical properties of any aquifer which largely control the movement of water through it. The first is the ease with which it transmits the water, analogous to the thermal conductivity of a solid in the theory of heat, or the electrical conductivity of an electrical circuit. This characteristic of the aquifer as a whole is called the coefficient o. transmissibility and is defined as the number of gallons of water that will pass in one day through a vertical strip of the aquifer 1 ft wide under a unit pressure gradient.

The other important characteristic of the aquifer is the amount of water that will be released from storage when the head in the aquifer falls. This has been called the coefficient of storage, and is defined as the amount of water in cubic feet that will be released from storage in each vertical column of the aquifer having a base 1 ft square, when the water level falls 1 ft. For non-artesian aquifers the coefficient of storage is nearly identical with the specific yield of the material of the aquifer. For artesian aquifers the coefficient depends on the compressibility of the aquifer or of included or stratigraphically adjacent shaly beds and is much smaller.

THE CONE OF DEPRESSION

Consider a broad flat slab of a metal that has been brought to a uniform temperature and one or more edges of which are continuously maintained at that temperature. Somewhere near the middle of this slab let us place a colder rod and draw off heat through this rod at a uniform rate. The temperature of the plate in the vicinity of the rod will be reduced, and the depression of the temperature at any particular place will depend on the thermal conductivity of the metal, its specific heat, and its thickness. When a well is drawn upon a closely analogous process occurs. Water levels are drawn down in the vicinity of the well. Some water is removed from the vicinity concurrently with this

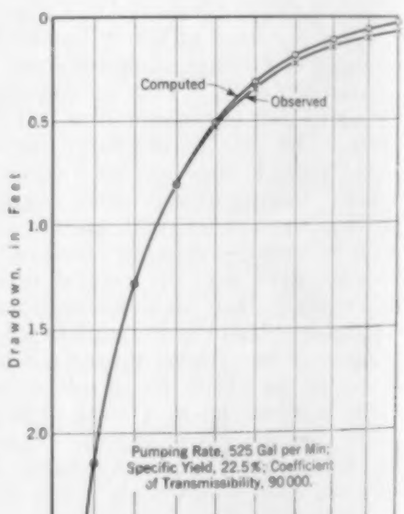

FIG. 3. OBSERVED AND COMPUTED DRAWDOWNS IN VICINITY OF A WELL AFTER PUMPING 48 HOURS

(After C. V. Theis, "The Relation Between the Lowering of the Piezometric Surface and the Rate and Duration of Discharge of a Well Using Ground-Water Storage," *Transactions*, American Geophysical Union, 1935, p. 521)

reduction in water levels, and a so-called cone of depression is formed. The shape of this cone is determined principally by the ease with which water flows through the aquifer—the coefficient of transmissibility—and by the coefficient of storage.

Figure 2 shows the position of the water table in the vicinity of a pumped well at several times during the course of pumping; that is, it shows the successive shapes and positions assumed by the cone of depression. With continued pumping the cone deepens and broadens. It is evident that the well is taking water out of storage in the vicinity and that as more and more water is removed by the well, the cone of depression affects more and more distant parts of the aquifer.

On the simplifying assumption that the removal of water is exactly analogous to the removal of heat from a metal plate, an equation for the drawdowns caused by pumping a well may be derived. That this equation is essentially true is shown in Fig. 3 by the comparison of computed and observed drawdowns after 48 hours of pumping in the test made by Mr. Wenzel. The observed values shown are the averages of all drawdowns measured in all the observation wells at the given distances from the pumping well. Throughout most of the cone the difference between observed and computed values is less than 0.01 ft, and the maximum error is less than 0.05 ft.

This formula for the cone of depression in the ideal homogeneous and isotropic aquifer assumed is:

$$v = \frac{114.6F}{T}\int_z^{\infty}(e^{-u}/u)du$$

in which

v = drawdown at any point, in ft
F = rate of discharge of the well, in gal per min
T = coefficient of transmissibility
z = $1.87\ r^2s/Tt$
r = distance between pumped well and point of observation, in ft
s = coefficient of storage
t = time the well has been discharging, in days
u = a dimensionless quantity varying between the limits given

Some of the simplifying assumptions used in developing this formula are not rigidly realized in nature. However, the tolerance of the assumptions made appears to be sufficient for the purposes of this paper.

The characteristics of this formula should be noted. The quantity represented by the definite integral has a value depending only on the value of the lower limit, z, which involves distance, time, transmissibility, and storage ability. This quantity in effect determines the virtual radius of the cone of depression. The two factors outside the integral cause a variation in drawdown proportional to themselves. Specifically, the rate of pumping causes a proportional variation in the depth of the cone but does not affect its radius. The coefficient of storage, s, because of its relation to time, affects the rate of lateral spread of the cone, the rate of lateral growth being inversely proportional to its value. The coefficient of transmissibility affects both the radius of the cone and its depth, the radius for any given time increasing with increasing transmissibility, and the depth being inversely proportional to the transmissibility. The important general principle is that, according to the formula, which appears to hold except for very short periods of pumping, the rate of growth and the lateral extent of the cone of depression are independent of the rate of pumping. If we pump twice as hard the cone will be twice as deep at any point, but it will not extend to any more distant areas. The disturbance in the aquifer created by the discharge of the well may be likened to a wave: the amplitude depends on the strength of the disturbance but the rate of propagation depends only on the medium in which the wave is formed. The reservoir from which the well takes water is almost as closely circumscribed by time as it would be by any material boundary, and until sufficient time has elapsed for the cone to reach the areas of natural discharge and rejected recharge a new equilibrium in the aquifer cannot be established.

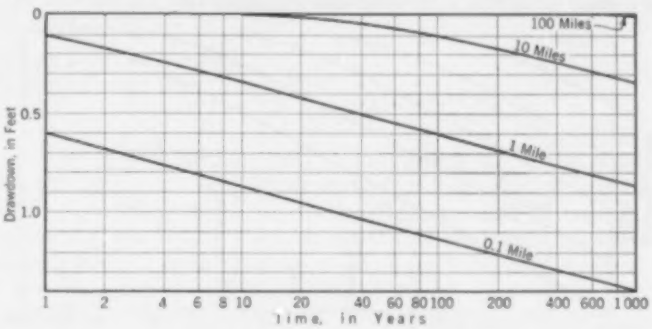

FIG. 4. DRAWDOWN IN AN IDEAL AQUIFER CAUSED BY CONTINUOUS DISCHARGE OF A WELL AT THE RATE OF 100 GAL PER MIN

(After C. V. Theis, "The Significance and Nature of the Cone of Depression in Ground-Water Bodies," *Economic Geology*, Vol. 33, No. 8, 1938, Fig. 1, p. 896)

The importance of this time effect varies with the characteristics of the aquifer and the distance from the well to the areas of recharge and natural discharge. An idea of the order of magnitude of the effect may be gained from Figs. 4 and 5. These are drawn for an aquifer whose coefficient of transmissibility is 100,000 and whose coefficient of storage or specific yield is 20%. These values are in the range of magnitude of the respective coefficients for most important non-artesian aquifers. The rate of pumping is 100 gal a min, or about 160 acre-ft a year. As the drawdown is directly proportional to the rate of pumping, the drawdown for any other rate of pumping can be readily computed.

Figure 4 compares drawndown with time at several distances from the pumped well. Time is shown on a logarithmic scale. There is a definite time lapse after pumping begins before the effects are felt at any given distance from the well. After a period of adjustment the fall of the water table proceeds approximately at a logarithmic rate. If the aquifer is extensive areally, and all the water withdrawn from the well is represented by a loss of storage in the aquifer, the drawdown at a distance of 1 mile from the pumped well in the first 10 years of pumping is over half of what it will be in 100 years.

Figure 5 plots the same data for several times against the distance from the pumped well. These are profiles of the cone of depression, with distance expressed on a logarithmic scale. Through most of their extent, these lines on the semi-logarithmic graph are practically straight. Within the radii represented by the straight portions of these lines, the aquifer is acting essentially as a conduit, merely carrying the water from more distant areas with only insignificant additions along the way. The significant additions are made in the regions where the lines are curved. This is the part of the aquifer that acts largely as a reservoir. Although theoretically the profiles of the cone of depression are asymptotic to the zero line, that is, the original position of the water table, and never quite reach it, except at the boundaries of the aquifer, practically speaking the cone has a definite edge beyond which neither the movement of the water nor its quantity is affected by the well. This edge, however,

is constantly retreating and is not fixed, as is implied in some of the texts on ground-water hydrology.

It has been said that the rate of growth of the cone is inversely proportional to the coefficient of storage. This point is of importance to the present discussion chiefly in its bearing on the difference between artesian and non-artesian aquifers. In artesian aquifers the coefficient of

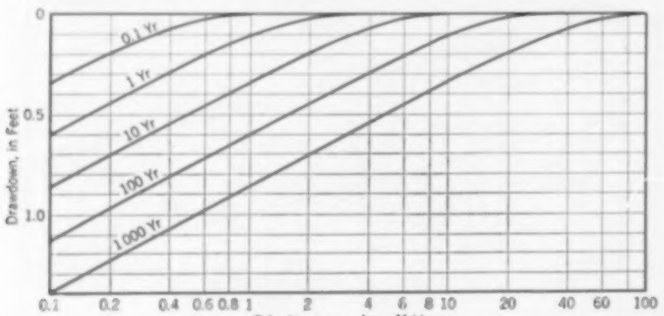

FIG. 5. DRAWDOWN FOR SAME CONDITIONS AS THOSE OF FIG. 4, PLOTTED AGAINST DISTANCE FROM DISCHARGING WELL

(After C. V. Theis, "The Significance and Nature of the Cone of Depression in Ground-Water Bodies," *Economic Geology*, Vol. 33, No. 8, 1938, Fig. 2, p. 897)

storage is dependent on the compressibility of the aquifer and probably included or adjacent shaly beds, and is of a magnitude only a few per cent or a fraction of 1% of that of non-artesian aquifers. Hence the cone of depression in artesian aquifers grows very roughly 100 times as fast as it does in non-artesian aquifers. Hence artesian aquifers, excluding the very extensive ones, are brought into a new equilibrium almost immediately and most of the effects of a new ground-water development are soon felt.

After the cone of depression reaches areas of rejected recharge or natural discharge, it is modified by the effects of adding water in the former or preventing it from escaping in the latter. If the rate of pumping does not exceed the amount of water added in the recharge area and that prevented from escaping in the discharge area, the cone will eventually reach equilibrium, at least practically speaking. The approximate effects that occur after the cone has reached the boundaries of the aquifer can be estimated by means of various mathematical analyses. The effects of discontinuous pumping can also be evaluated.

In summing up this technical discussion from the standpoint of ground-water conservation and statutory or other regulation to that end, the following points should be emphasized:

1. All water discharged by wells is balanced by a loss of water somewhere.

2. This loss is always to some extent and in many cases largely from storage in the aquifer. Some ground water is always mined. The reservoir from which the water is taken is in effect bounded by time and by the structure of the aquifer as well as by material boundaries. The amount of water removed from any area is proportional to the drawdown, which in turn is proportional to the rate of pumping. Therefore, too great concentration of pumping in any area is to be discouraged and a uniform areal distribution of development over the area where the water is shallow should be encouraged, so far as is consistent with soil and marketing or other economic conditions.

3. After sufficient time has elapsed for the cone to reach the area of recharge, further discharge by wells will be made up at least in part by an increase in the recharge if previously there has been rejected recharge. If the recharge was previously rejected through transpiration from non-beneficial vegetation, no economic loss is suffered. If the recharge was rejected through springs or refusal of the aquifer to absorb surface waters, rights to these surface waters may be injured.

4. Again, after sufficient time has elapsed for the cone to reach the areas of natural discharge, further discharge by wells will be made up in part by a diminution in the natural discharge. If this natural discharge fed surface streams, prior rights to the surface water may be injured.

5. In most artesian aquifers—excluding very extensive ones, such as the Dakota sandstone—little of the water is taken from storage. In these aquifers, because the cones of depression spread with great rapidity, each well in a short time has its maximum effect on the whole aquifer and obtains most of its water by increase of recharge or decrease of natural discharge. Such an artesian basin can be treated as a unit, as is done in the New Mexico ground-water law, and the laws of some other western states that follow this law. In large non-artesian aquifers, where pumping is done at great distances from the localities of intake or outlet, however, the effects of each well are for a considerable time confined to a rather small radius and the water is taken from storage in the vicinity of the well. Hence these large ground-water bodies cannot be considered a unit in utilizing the ground water. Proper conservation measures will consider such large aquifers to be made up of smaller units, and will attempt to limit the development in each unit. Such procedure would also be advisable, although not as necessary, in an artesian aquifer.

6. The ideal development of any aquifer from the standpoint of the maximum utilization of the supply would follow these points:

(*a*) The pumps should be placed as close as economically possible to areas of rejected recharge or natural discharge where ground water is being lost by evaporation or transpiration by non-productive vegetation, or where the surface water fed by, or rejected by, the ground water cannot be used. By so doing this lost water would be utilized by the pumps with a minimum lowering of the water level in the aquifer.

(*b*) In areas remote from zones of natural discharge or rejected recharge, the pumps should be spaced as uniformly as possible throughout the available area. By so doing the lowering of the water level in any one place would be held to a minimum and hence the life of the development would be extended.

(*c*) The amount of pumping in any one locality would be limited. For non-artesian aquifers with a comparatively small areal extent and for most artesian aquifers, there is a perennial safe yield equivalent to the amount of rejected recharge and natural discharge it is feasible to utilize. If this amount is not exceeded, the water levels will finally reach an equilibrium stage. If it is exceeded, water levels will continue to decline.

In localities developing water from non-artesian aquifers and remote from areas of rejected recharge or natural discharge, the condition of equilibrium connoted by the concept of perennial safe yield may never be reached in the predictable future and the water used may all be taken from storage. If pumping in such a locality is at a rate that will result in the course of ten years in a lowering of water level to a depth from which it is not feasible to pump, pumping at half this rate would not cause the same lowering in 100 years. Provided there is no interference by pumping from other wells, in the long run much more water could be taken from the aquifer at less expense.

The Port of New York—Improvement by the City

By J. A. Meehan

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New York City's insular position brings it peculiar problems as a port, such as the necessity for rail-borne freight to hurdle the obstacle of the Hudson River. Collaborating with shippers, the city authorities have developed a special shape of pier, relatively narrow, but meeting all requirements, particularly that of self-sustaining economy. Typical construction consists of a steel superstructure, with concrete floors, supported on wooden pile bents. More recently, in addition to problems of commerce by sea, the city has recognized and met the needs of air traffic. The paper is one of a series on this port, originally presented before the Waterways Division at the Annual Meeting in January.

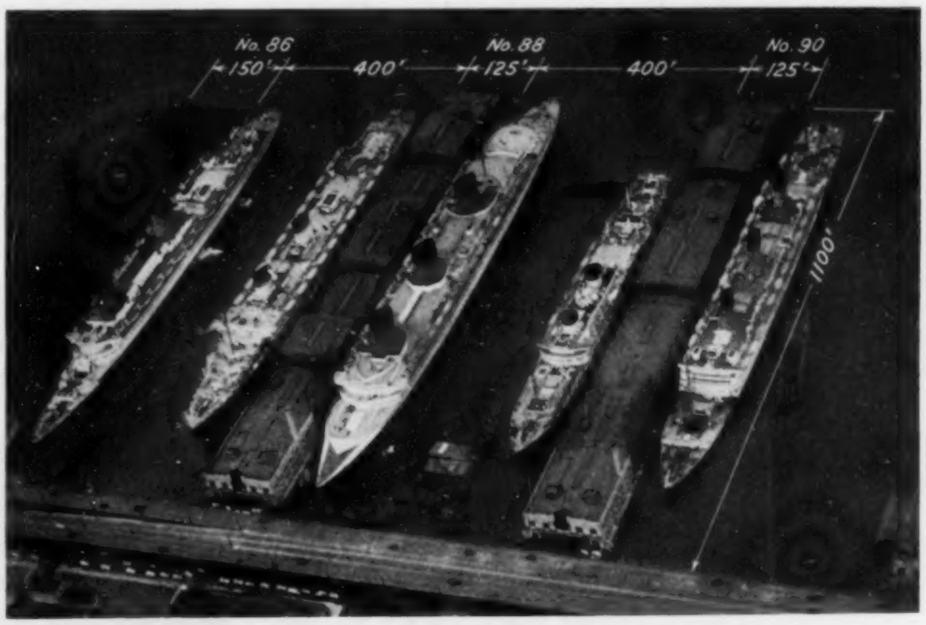
Many unique problems are presented in the development of the Port of New York. A glance at a map of the harbor (Fig. 1) will disclose the existence of a continuous waterway which divides the port into two parts. For purposes of discussion, we may consider the easterly part as lying in the State of New York and the westerly part as in New Jersey. This waterway is made up of Ambrose and Gedney channels leading in from the Atlantic Ocean, the Lower Bay, the Narrows, the Upper Bay, and the Hudson River.

It should also be noted that the waterfront property along the westerly side of the Hudson River is almost entirely occupied by railroad terminals with their classification yards, serving the entire port. On the opposite side we find the waterfront intensively used for steamship docks. Because of these conditions, almost two-thirds of the freight entering the harbor by ship and rail is ferried across the river, necessitating the use of a great many car floats, lighters, and barges. In addition the railroads are operating ferry services back and forth across the river for the convenience of thousands of commuters and for the handling of motor vehicles. The coordination of all these facilities is the main problem in the development of this port—a problem long recognized and now the subject of much research and study in an effort to solve it.

Of the twelve railroads entering the port, only three connect directly with any of the boroughs of the city, and only one, the Baltimore and Ohio on Staten Island, connects with the ten railroads on the west shore of the Hudson River which transport a very large percentage of the freight carried to and from the harbor by rail. Even if the suggested tunnel from Greenville to Bay Ridge were built to serve the Brooklyn and Queens waterfront by means of a belt railroad connecting the railroads on the New Jersey shore, and if a belt line were added to connect the various railroad terminals along the Brooklyn shore now served by car float, the problem of Manhattan Island, the commercial and financial center of the port, would still remain.

Today the railroads occupy about one-third of the facilities available for commerce on the North River waterfront of Manhattan between the Battery and West 59th Street, and also maintain car-float bridges at four locations between West 23d Street and West 42d Street. Within this zone the upland immediately adjoining the waterfront is used almost exclusively for railroad yards. Any method of getting goods from the railroad terminals on the mainland on the Jersey side of the river that will eliminate or even reduce the number of car floats, float bridges and ferries, without further increasing the cost of handling, will be welcome indeed. The present ferry slips and the tunnels crossing the river fix the limits within which it is possible to make new improvements. Studies for the modernization of this stretch of waterfront are now in progress.

With all admiration for the fine piers of Baltimore, Philadelphia, and Boston—with their great widths, depressed railroad tracks extending out their full length, and classification yards behind—which provide an excellent solution of their problem for the speedy, efficient, and economical handling of goods, we feel that the problem in New York is different, and that what serves those cities so well would not serve at all for the Hudson River. Most visitors to these transatlantic steamship piers



Some of the World's Largest Liners at New Transatlantic Terminal, West 46th to 52d Streets, Manhattan

From Left, Europa (German); Rex (Italian); Normandie (French) Georgic and Berengaria (British)

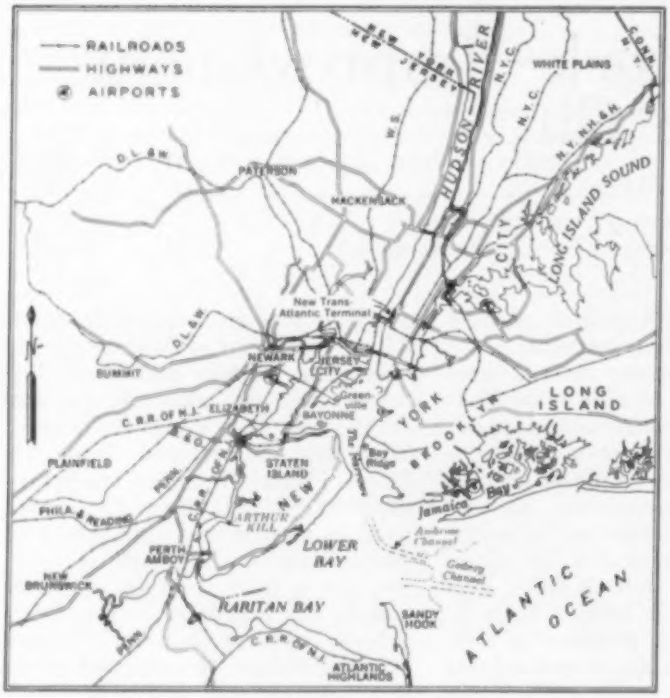


FIG. 1. NEW YORK'S METROPOLITAN PORT AREA

who are familiar with construction in other harbors, express surprise at the lightness of construction of the substructure, the narrowness of the piers as compared with their great length, and the lack of direct rail connections and cargo handling cranes along the sides.

These apparent defects are not due to any lack of foresight on the part of the engineers and administrative officers of the city's Department of Docks. For many years studies were made for railroad tracks along the marginal street, with classification yards and connections with the railroads on the west side of the river—by tunnel or a battery of float bridges located far enough to the north of the steamship piers to avoid any cross traffic; but the idea did not receive the support of the people of the city. The New York Central tracks on Eleventh Avenue and along Riverside Park were too good an example of the drawbacks of having a railroad running through a city, so that a great deal of talk about efficiency and economy failed to arouse any interest in the larger plan.

THE ECONOMICS OF PIER DESIGN IN NEW YORK

The narrowness of the piers is not solely due to the judgment of the engineers of the Department of Docks. New York differs from most other ports in that its docks are financially self-sustaining, that is, the rental is based upon the cost of the property acquired for the improvement, the cost of the physical development including substructure, superstructure, bulkhead wall, dredging, and similar details, with proper allowance for depreciation, obsolescence, and amortization of the bonds issued to finance the improvement. Even the loss of taxes by reason of the property's having been taken out of private ownership, is taken into consideration.

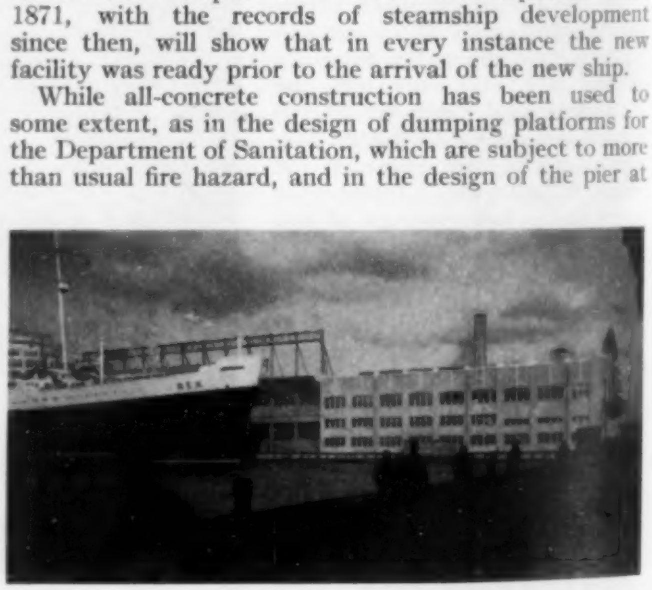
When a so-called new plan is laid out—that is, a map showing the outline of the piers which it is proposed to build in a certain section—and prospective lessees come in to discuss their requirements, the rentals, and other factors, they usually feel that both the piers and slips should be much wider. But when figures are prepared based on the additional cost of the structures, land under water, and bulkhead rights, these clients almost invariably conclude that the convenience and economy of handling cargo on wide piers with plenty of working space, and wide slips with ample room for ships, lighters and barges, is more than offset by the additional rental required to carry the extra pier and slip space.

That there is congestion on these piers when ships are receiving or discharging cargo must be admitted, but so is there congestion in any other desirable business section of Manhattan, and the degree of congestion is more often than not a measure of the value of the neighboring property. Even if it were possible to build wide piers of the solid filled-in type along the Hudson River (and it is not possible, first because the War Department would not permit this type of construction on account of the contraction of the tidal prism, and second, because the slips would very soon become a nuisance), it is doubtful that the city would be the gainer by such an arrangement. As I see this problem it is better to have three piers, each leased to a separate steamship company, and busy most of the time with ships arriving and departing at frequent intervals, than to have the same three piers, or two occupying the space of the three, leased to one company and busy half of the time; even though the rental received is the same.

Of course we have tried to obtain a maximum of berthing accommodation from a given length of bulkhead; but we have also tried to avoid the sacrifice of necessary slip or pier width, having in mind that the purpose of these piers is to provide a safe berth for the largest liners, and a pier of sufficient width to discharge and take on passengers and cargo, rather than in any sense to act as a warehouse. We feel that with piers 1,100 ft long and 150 ft wide, and with slips of 350 to 400 ft wide, we have solved our problem. There will be changes, of course—minor changes in widths of piers and slips; radical changes, perhaps, in the materials of the substructures—but we think that the general design will remain about as it is for a long time.

One of the major functions of the Department of Docks is to maintain the position of the waterfront continually in advance of ship building and industrial developments. A comparison of the new plans for pier construction adopted and carried to completion since 1871, with the records of steamship development since then, will show that in every instance the new facility was ready prior to the arrival of the new ship.

While all-concrete construction has been used to some extent, as in the design of dumping platforms for the Department of Sanitation, which are subject to more than usual fire hazard, and in the design of the pier at



VISTA OF PIER 92, NEW OCEAN TERMINAL, HUDSON RIVER AT WEST 52D STREET
Edge of West Side Elevated Highway Shows at Upper Right

Canarsie, Jamaica Bay, yet in the design of the large steamship piers along the Hudson River wood piles have been used almost exclusively. The reasons for this are rapidity and economy of construction and repairs, combined with the useful life of the pier.

It has been our experience that wood piles will last from twenty to thirty years, after which time they can be cut off at about a foot above low water and posted or bench capped. They are then in good condition for another twenty years. This work can be done without disturbing the shed or pile caps. At the end of fifty years it is not likely that the pier, even if in good condition, will bring sufficient rental to justify its existence; that is, it will probably have to make way for some new structure.

RESEARCH ON MARINE BORERS UNDER WAY

While on the subject of pile foundations, I want to refer briefly to the fact that the City of New York has spent millions of dollars on sewage disposal works and is planning to expend many more during the next fifteen years to complete its program. Up to the present time, the harbor of New York has been almost entirely free from attack by teridinidae, limnoria, and other marine borers, and apparently the cause of our immunity has been the pollution and sewage in the tidal streams. It is expected that the completion of the sanitary program will result in eliminating practically all the pollution now caused by sewage. What effect this will have on our immunity from attack by marine borers is difficult to determine at this time. For some time past, the Department of Docks has been carrying on observations and research with a view to determining the present situation and to obtaining data on which to base an intelligent conclusion.

A program of modernization, carried out in progressive stages, so as not to destroy existing suitable accommodations, has been inaugurated by the Department of Docks. Over a period of years twenty old structures along the east shore of the Hudson have been replaced by bulkheads and eleven new piers. In addition, the new transatlantic terminal between West 46th Street and West 52d Street, consisting of four large and long (1,100 ft) piers has been built at a cost of about 16 million dollars. These are for the accommodation of the de luxe superliners of the French, Cunard, and Italian lines. Various other sections of the New York waterfront were also improved under this program. Prior to the design and construction of our modern piers, conferences are held with representatives of the companies that are to use them, to work out details as to pier length, width, type of building, and equipment.

Of special interest to engineers is the type of pier generally favored by the City of New York for the large transatlantic liners which berth along the Hudson River—and the reasons for preferring such design and construction over others that have been suggested. The standard type of pier consists of a heavy reinforced-concrete deck designed to carry a load of 500 lb per sq ft and generally 10 in. thick; supported by timber caps spaced 10 ft on centers, in turn carried on pile rows likewise spaced 10 ft on centers. The piles are driven to such penetration as to produce a bearing capacity of 15 tons. The bottom is explored in advance of any construction work, by means of soundings, test piles, and borings to ascertain the length of the piles required. Underneath, the pier is divided into sections of 120 to 140 ft, with concrete fire walls running transversely and extending from low water to the under side of the concrete dock. This construction considerably reduces the fire hazard. Concrete footings for the columns of the superstructure are carried to low water, where they are supported on clusters of piles properly capped.

The superstructure is usually a two-story building consisting of four-column steel bents, spaced 20 ft on centers with heavy steel framing and with a concrete deck as the second floor to carry a live load of 300 to 400 lb per sq ft. The sides of both floors are fitted with heavy two-section turnover doors, also with special doors and wharf-drops where conditions require. On the inshore or front portion is the "bulkhead shed," laid out to provide passenger waiting rooms, offices, boiler rooms, and rooms for electric equipment, switchboards, and other appliances. The front and sides of the buildings are of steel frame with brick, limestone, or terra cotta façades, modern in design and suitable for ship terminals.

INTERIOR OF NEW PIER 45, WEST 10TH STREET AND HUDSON RIVER, SHOWING BAGGAGE CONVEYOR, FIRST FLOOR
An Electric Eye Counts Moving Packages, as a Check

WATER SUPPLY EQUIPMENT AN IMPORTANT ITEM

In a big steamship terminal the water supply equipment is no small item. Mains of sufficient size must be provided to supply water to sprinkler system, standpipe system, and also to all offices. Last but not least, they must supply fresh water for the ships—particularly for boiler use. Thus the water mains in the larger piers are designed to deliver 4,000 gal per min at the extreme end of the pier. Water tanks of a ship such as the *Normandie* hold about 1,000,000 gal, and enough ship manifolds are provided to fill the tanks in a few hours.

Modern terminals are provided with passenger elevators and escalators in addition to stairways for the rapid movement of passengers on days of sailings and arrivals; also with baggage conveyors, gravity chutes, freight elevators, and other equipment for the quick discharge of freight. They all have automatic sprinkler systems, fire alarm systems, and other means to protect against fire hazard—with a resulting reduction in insurance rates, on both buildings and cargoes.

Dependent on the needs of the lessee company, the light and power layouts will of course vary. On some piers the supply feeder system consists of twenty-six 700,000 circular mil wires from transformers which terminate at the switchboard, from which a network of feeders carry current to the lighting circuits as well as

to all power equipment. The modern terminals are equipped with oil-burning systems to heat all the numerous offices and waiting rooms to a temperature of 70 F. Two boilers of sufficient capacity are generally installed; in milder weather only one boiler is in operation. The heavy oil used in the boiler is stored in large underground tanks of 7,500-gal capacity. Oil may be supplied either from a barge through a special feed line or from the land side by tank trucks. Incinerators are also installed on the piers so that refuse and garbage from the ships and piers can be quickly disposed of. Sometimes the question is asked why we do not build masonry piers and sheds, or multiple-story buildings. Experience shows that such structures are not economical. Because of changing commercial conditions, they become obsolete before their investment can be amortized. Steamship companies will avoid using a masonry pier if suitable accommodations can be had at a pile pier, because of possible damage to their vessels. Pier 1 on the North River, a stone arch pier, is an example. The bottom conditions obtaining along the waterfront make the cost of such construction prohibitive.

GROWING IMPORTANCE OF AIR TRANSPORTATION

In any study for the development of the port, it is most important to make a complete analysis of all the methods of transportation. Heretofore such analyses were confined almost solely to operations by ship and rail. Today, another form of transportation has reached such a stage of development that it warrants serious consideration. I refer to the operation of regular scheduled air transports in and out of the airports of the metropolitan area.

There is ample evidence of the great strides being made in this industry. In 1934 the air-line companies operating 417 planes in the United States carried almost half a million passengers, and in doing so flew more than 180 million passenger miles. During 1939, these companies, using 283 planes, carried more than a million and a half passengers and probably flew more than 600 million passenger miles. The increased capacity of the modern plane accounts for the reduced number of planes in service.

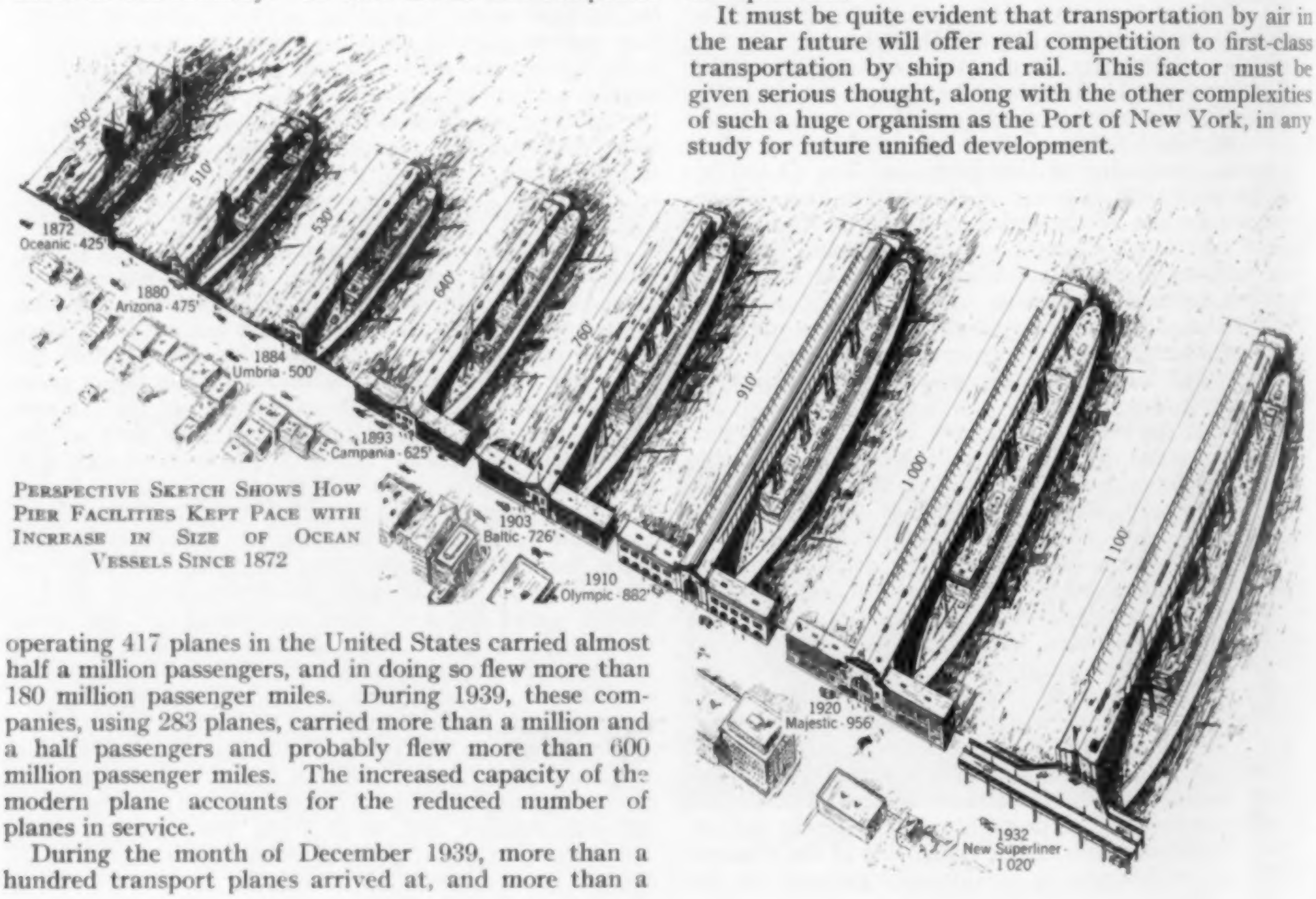
During the month of December 1939, more than a hundred transport planes arrived at, and more than a hundred departed from, the New York area. For land-plane operation 76 new ships have been ordered, 37 of which will be in operation in 1940 and the remaining 39 in 1941. The capacity of these new planes—40 passengers plus 5 in the crew—is about double that of those now in service, and their cruising speed will be about 30 miles an hour faster.

During 1936 all the steamers operating in and out of the Port of New York carried 151,397 first-class and cabin passengers. During the same year, the American Airlines carried in and out of New York 127,850 passengers, and the total for all the air lines operating out of New York was 303,891 passengers, almost exactly double the steamship figures.

Surprising as it may seem, modern transport planes are capable of carrying the U.S. mail at a lower cost per ton mile than is now being paid for surface transportation. In the 11 days immediately preceding the Christmas holidays of 1939, seventy-five tons of air mail was flown from the New York area. I do not have the figures for air-express shipments.

The Pan American Airways Company is now operating five transatlantic ships from the east coast, making trips to Bermuda, Horta in the Azores, and Lisbon, Portugal. Operations from New York commenced the first Sunday in April with four "clippers" in and out each week, and the company is planning on placing six new ships in this service. The flight to Bermuda is made in about five hours, the ship carrying about 60 passengers and a crew of 11. The transatlantic crossing is made in about 32 hours with about 25 passengers. During operations in 1939, a hundred round trips were made, aside from many survey flights, and the company transported about 1,800 passengers to Europe and about 5,000 to Bermuda, in addition to 56,000 lb of European mail.

It must be quite evident that transportation by air in the near future will offer real competition to first-class transportation by ship and rail. This factor must be given serious thought, along with the other complexities of such a huge organism as the Port of New York, in any study for future unified development.



PERSPECTIVE SKETCH SHOWS HOW PIER FACILITIES KEPT PACE WITH INCREASE IN SIZE OF OCEAN VESSELS SINCE 1872

Static Tests of Riveted Joints

Emerging Ideas, Based on American and Foreign Research—a Paper from the Structural Division Program at the 1940 Annual Meeting

By Jonathan Jones

Member American Society of Civil Engineers
Chief Engineer, Fabricated Steel Construction, Bethlehem Steel Company, Bethlehem, Pa.

After citing the main American tests, Mr. Jones describes significant structural actions in steel joints, such as the increase in rivet strength due to heating and driving, and the effects of friction of the component parts. Whatever the load distribution among the rivets at the start, it tends to equalize at the point of failure. Most consistent and accurate stress values for shear result from joints in double shear. A working value of 40,000 lb is warranted for "enclosed bearing." The paper concludes with suggestions for taking care of end punching and for utilizing high-strength rivets for connecting high-strength steel. A similar review covering fatigue in riveted joints will appear in a following issue of "Civil Engineering."

The literature on riveted joints is extensive, and reaches back many years. Engineers of many countries have contributed, and those in the ship-building industry more than those in the structural field. In very recent years the British Steel Structures Research Committee has been attacking structural research anew, with an intensity and a concentration of effort that we Americans have not approached, and has included some fundamental studies of riveted joints.

In America the principal test programs that must be taken into account in appraising our knowledge and our specifications are:

1. "Tests of Riveted Joints," by the American Railway Engineering and Maintenance of Way Association (*Proceedings* of the Association, Vol. 6, 1905, page 272). Incidentally, this volume contains an interesting history of bridge design practice and specifications in the nineteenth century.
2. "Tests of Nickel-Steel Riveted Joints," for the Quebec Bridge Commission (Bulletin No. 49, University of Illinois Experiment Station, 1911).
3. Tests of carbon steel joints by E. L. Gayhart (*Transactions* of the Society of Naval Architects and Marine Engineers, Vol. 34, 1926, page 55).
4. Tests of the bearing value of carbon steel rivets, reported by Jonathan Jones to the American Institute of Steel Construction, 1935. While circulated to some extent, these tests have not been published; a copy is being filed with the Society.
5. "Tension Tests of Large Riveted Joints," by Davis, Woodruff, and Davis (Proceedings, Am. Soc. C.E., May 1939). This investigation overshadows all previous ones in size of members tested and variety of problems considered.
6. Report to American Society of Testing Materials, by its Section on High-Tensile Rivet Steel, 1938. This report, a copy of which is being filed with the Society, deals only with one type (silico-manganese) of high-strength rivet. Comparative data on other compositions are expected to be available later.

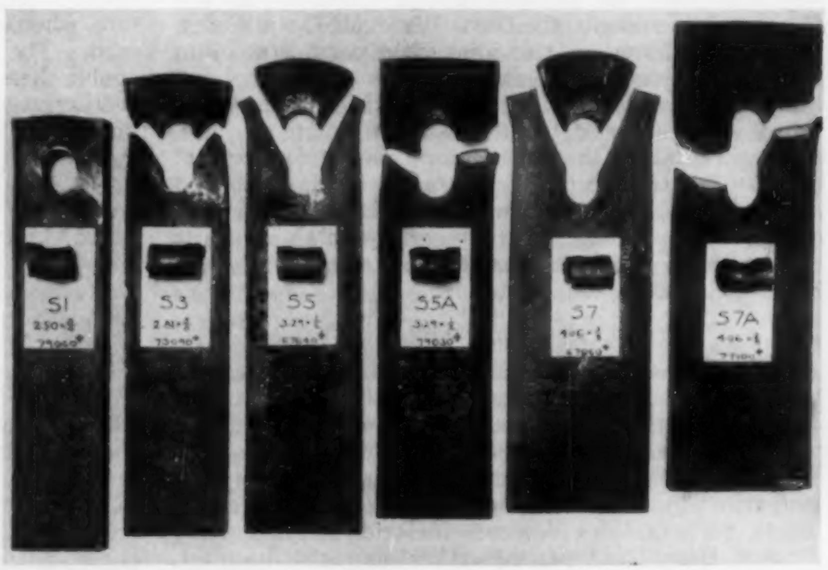
There is, in addition, a comprehensive bibliography entitled "Critical Review of the Literature on Riveted Joints," by A. E. R. de Jonge, M. Am. Soc. C.E., which is announced for publication during the current year by the American Society of Mechanical Engineers, under whom the research was done. It enables all the data on any problems connected with static rivet testing to be located.

In what follows references to the foregoing literature will be made by number. No complete résumé is contemplated, but rather an attempt to outline the governing facts which these and other published reports bring out.

The act of heating and driving a rivet raises its yield point and its ultimate strength. Our standard rivet steel has a specified minimum yield point of 85%, and a specified minimum ultimate tensile strength of 87%, respectively, of those of standard plates and shapes. But if hot-driven, removed from the work, and tested in tension, rivets will be up to 100% in yield point and 97% in ultimate strength. Therefore, rivets should not be thought of as being softer than the material they join. They are made just enough softer initially so that after fabrication they will be as strong as the plates.

Yield Point Strength

Obviously the wording of most specifications, that "rivets shall fill the holes," must be taken with a grain of salt. A rivet will fill its hole while it is being driven and is still red hot; in cooling it must shrink slightly in diameter. Also, as it cools down to a few hundred degrees



Failed Specimens from Special Tests of Bearing Value of Rivets by Bethlehem Steel Company, 1935
Increase of Breaking Load of "5A" Over "5," and of "7A" Over "7," Is Due to Increased End Distance, as Indicated

TENSION CHORDS FOR A TRUSS BRIDGE BEING FABRICATED—NOTE GREAT NUMBER OF RIVETS

Fahrenheit and begins to pick up tensile strength, and as its effort to contract in length is frustrated by the material into which it has been driven, it will attain a tensile stress approximating its yield point, producing a clamping or frictional effect upon the plates.

Therefore the joint shear tests in which extensometer measurements have been taken follow an understandable pattern. At first the stress-strain curve is straight and steep, representing the unbroken frictional resistance. Then comes a jog in the line, as the friction is broken, the small clearances are taken up, and the rivets begin to bear against the sides of their holes. Again the stress-strain curve becomes straight, and steep, as the materials work elastically under the shearing and bearing forces. Then there comes a break, more or less a knee, as something in the joint begins to flow, and thenceforeward there is a constantly increasing flatness of the line, or increase of strain-stress ratio, until failure occurs. In other words, the stress-strain curve of a riveted joint looks like that of any piece of structural steel, except for the early and temporary break at the point where friction is overcome.

Often the upper or true joint yield point is not clearly defined, and may have to be scaled off by drawing a tangent line at an arbitrarily chosen slope, as is done with any steel that has no well-defined "drop of beam." However, according to the Davis-Woodruff-Davis report, previously referred to, this joint yield point is at 57 to 75% of the joint's ultimate strength. In my opinion that is all we need to know about it. If customary factors of safety are used, based upon the ultimate strength, there will be about the same factor of safety with respect to the yield strength of the joint as with respect to that of the main material. Therefore it is good policy to emphasize the ultimate joint strength, which is a definite unmistakable value, subject to no arbitrary or even highly painstaking determination.

DISTRIBUTION OF LOAD OVER RIVETS

Because a joint has an elastic range, theoretical studies have been made, by principles of elastic action, of the distribution of the total load over its several, or many, rivets. These studies indicate that the end rivets, in a joint having three or more in line, must carry far more load than any of the intermediate ones. Test measurements, such as those reported in Reference 5, roughly confirm this. This paper further suggests, however, that this maldistribution irons out as the joint enters its plastic range, and that at failure the rivets are under practically equal loads. If it is the rivets that fail, few and usually none fail before the entire group lets go. The authors recommend that designers regard all rivets in a joint as carrying equal loads. This, as C. F. Goodrich, M. Am. Soc. C.E., points out (PROCEEDINGS for September 1939, page 1292) "is a very reassuring conclusion and inspires further confidence in large riveted joints."

In this connection, without seeming to condone poor work, and speaking particularly be it remembered, of non-reversing joints, I would decry the over-emphasis that is laid on tightness of rivets. Refined methods are sometimes used to detect the slightest so-called "jar" in heads. Now many shop tests have proved, by sectioning of rivets which tap with or without a "jar," that there is no fixed relation between this "jar" and the filling of the hole. There is no criterion that will tell how a respectably driven rivet fills its hole, except to take it out and measure it.

The theory of insistence on tap-tightness is presumably this: that since the load is first carried by friction, any rivet which does not contribute friction is throwing off load onto its neighbors. Suppose it does. In the early loading stages, where friction still exists, theory and tests have shown that the end rivets carry most of the load—and nothing can be done about that. Before a third of the joint capacity has been reached, all friction has been broken, all the rivets are in bearing, and thenceforward they more and more approach equality of load. Why do we worry about the early inequality? It bears no relation to the ultimate strength of the joint. Unless a rivet has definitely not been properly upset within the hole, it adds its unit share to the total static strength regardless of the presence of a "jar" in its head.

STRENGTH OF RIVETS IN SHEAR

The unit shearing strength of rivets tested in single-shear joints is somewhat greater than that of double-shear joints. This may be because in single-shear the plates bend and develop friction, or it may be because the rivet is put partially into tension by this distortion of the plates. It is evidently better to base shearing values upon double-shear specimens, which are easily freed of those distortion influences, and hence are more dependable and also somewhat lower in unit value.

Shearing tests of undriven rivets, in a shearing block, are no indication of the strength of rivets driven in a joint, because they are partially annealed in manufacture, whereas the driven rivet will be considerably hardened. The proper test on which to base rivet shear is a double shear test, using plates thick enough to eliminate bearing as a factor, and applying graphite to the faying surfaces before riveting, so that plate friction will be negligible.

Tests on joints thus made under my direction showed great consistency. In all, 13 different compositions were tested. For every composition there were 12 specimens, 3 each of 1-rivet, 2-rivets-in-line, 4-rivets-in-line, and 4-rivets-in-a-square. For the 12 specimens of any given composition, the unit shearing strength per rivet for any one specimen varied with three exceptions not more than 5% from the average for the 12.

Our standard rivet steel has a specified minimum tensile strength of 52,000 lb per sq in. Driving will increase this to about 58,000 lb. If shearing strength is 75% of tensile, the shearing strength will be about 43,500 lb.

Direct testing of the riveted joints just mentioned indicates that the unit strength of the rivet in double-shear joints will be about 90% of the tensile strength of the annealed bar, or about 45,000 lb as a minimum. Therefore the allowable values of 13,500 lb in our standard bridge specifications, and 15,000 lb in our standard building specifications, represent assured factors of safety

of 3.33 and 3.0, respectively, or the same as in main tensile material (for which the respective ratios are 60,000:18,000 and 60,000:20,000).

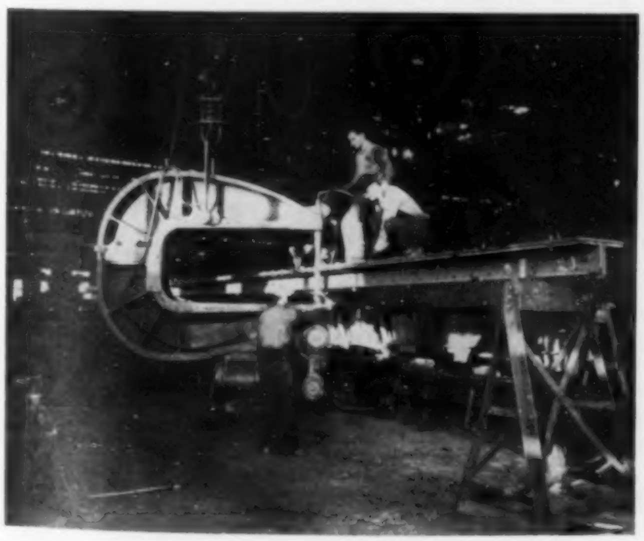
ALLOWABLE STRESS ON RIVETS IN BEARING

Reference 4 opens with the statement that the rivet-bearing unit stress permitted under American specifications was always notably less than that under German specifications, until the adoption of the value of 40,000 lb per sq in. for "enclosed bearing" in the A.I.S.C. Specifications for Buildings in 1936. In that reference there are digested 12 items, American and foreign—all I could find that touched on allowable bearing. Neither there nor elsewhere could I discover who first specified, and why, that the bearing value should be twice the shear.

While this popular relationship is unfair to bearing, it makes little practical difference in bridge work. In building work, however, it not only added unnecessary rivets but, more important, it too much restricted the application of the standard two-angle beam connections, requiring the detailing of special connections, with additional web rivets, for the thinner-webbed beams, which in reality required nothing of the sort.

The value of 40,000 lb per sq in. for enclosed bearing, adopted in the A.I.S.C. Specification of 1936, resulted from some special tests (Reference 4). Bearing was studied by varying bearing alone, keeping rivet shear and plate tension constant. In the thinnest material tested, rivet bearing reached 165,000 lb per sq in. before joint yield was observed, and 204,000 lb before failure occurred. The least ratio of breaking load to permissible bearing load of 40,000, was 3.85. In fact it seemed from these tests that for static loading, bearing on structural rivets might be forgotten without reduction of the safety factor.

One further fact, previously overlooked, developed in the tests just referred to—with this material the actual danger is not that a rivet will fail in bearing, but that it will punch out the end of the plate. The time-honored end distance of $1^1/_2$ in. is quite inadequate except where circumstances prevent this end punching. In so few experiments it was hardly possible to demonstrate a satisfactory rule for avoiding this punching weakness; but a simple and approximate rule was evolved and added to the A.I.S.C. Specification (Section 18), which calls for as much shearing area in the plate behind the rivet as in the rivet. It is interesting to note that this danger was



Yoke Riveter Being Used to Fabricate a Flange for a Plate Girder

Rivet Pattern on the Klingle Valley Arch Carrying Connecticut Avenue, Washington, D.C.
Modjeski, Masters and Case, Consulting Engineers

clearly illustrated in the A.R.E.A. tests of 35 years ago (Reference 1), but nothing was ever done about it until A.I.S.C. took it up in 1936.

Although silicon steel, which is one-third stronger than carbon bridge and building steel, has become a standard product and is annually used in thousands of tons of medium and long-span bridge work, it still is almost universally riveted with carbon rivets. Since the lower strength of the latter determines their number, it also determines the sizes of gusset and splice plates, and partially offsets the economy of the stronger steel. This practice is not necessary. The research reported in Reference 6, plus the few applications actually made to bridge work, as well as the constant applications made by the Navy, fully justifies the use of a high-strength rivet in high-strength material if and where it will promote economy.

One obstacle to its use has been that by adopting a steel considerably harder than needful, there has been introduced a difficulty in driving, and a lack of ductility in the finished rivet, which were unacceptable. To avoid this, care should be taken to select a rivet steel no harder than just hard enough. These high-tensile steels are apt to have high hardening ratios.

A large group of tests has established that the ratio of shearing strength of driven rivet to ultimate tensile strength of annealed bar is over 95%. Starting with a desire for a working stress in shear of 20,000 or 22,000 lb per sq in., the need is for an ultimate shearing stress of 64,000. This divided by 95% gives about 68,000. Specification A 195-T of the A.S.T.M. requires that the annealed bar shall show 68,000 to 82,000 tensile strength, thus assuring on the one hand adequate shear for the job, and avoiding on the other hand a tendency toward brittleness. A driven rivet of the hardest steel under this specification will show better than 25% elongation in 2 in.

It would be most uneconomical to use this rivet for stitching purposes, or where the strength of the rivet does not govern directly the number employed. But for splices and joints it should be more generally recognized that an appropriate high-strength rivet steel is available.

Other features of modern development in the understanding of the static behavior of riveted joints could be cited; but enough has been given in this summary to point to the research work which has had, or promises to have, an influence upon specifications for ordinary structures.

Legal Registration of Professional Engineers

A Review of the Problems Faced and Progress Made to Date

By T. Keith Legaré, M. Am. Soc. C.E.

Member of Society's Committee on Registration of Engineers; Executive Secretary, National Council of State Boards of Engineering Examiners, Columbia, S.C.

In 1907 Wyoming adopted the first state law regulating the practice of professional engineering and was followed closely by Louisiana in 1908, then by Illinois in 1915 and by Florida in 1917. However, it was not until the period from 1919 to 1922, when 17 states joined the registration group, that the registration of engineers became a nation-wide movement. (See Fig. 1.)

There now remain only six states—Delaware, Massachusetts, Missouri, Montana, New Hampshire, and North Dakota—which do not have laws requiring the registration of engineers, and three of these have active committees that are preparing such legislation. Hawaii, Puerto Rico, and the Philippines have engineering registration laws. The District of Columbia has a registration bill pending in Congress, and Alaska has appointed a committee to investigate the desirability of a registration law. Several states are now considering amendments to existing laws in order to include additional classifications or to improve the provisions for administration and general procedure. The trend of engineering registration in recent years seems to indicate that in a few more years every state in the Union will require the legal registration of all professional engineers who are in responsible charge of engineering work wherein the public welfare and the safeguarding of life, health, or property are concerned.

A significant feature of the administration of state registration laws has been the high type of personnel composing the state registration boards. Those serving on these boards have rendered effective and unselfish service to the public and to the engineering profession. There has been very little evidence of political activities, such as were predicted by opponents of registration, and with few exceptions the administration of registration laws, with all its complicated problems, has been handled just as any other engineering project should be handled—efficiently and honestly.

Lessons Drawn from Experience of Other Professions

Some very appropriate statements were recently made in an address by Prof. C. C. Knipmeyer, member of the Indiana State Board of Registration for Professional Engineers and Land Surveyors and Director of the National Council. A part of this address follows:

"The history and experiences of other professional groups are worthy of closest study on the part of engineers. The licensing of lawyers was found imperative for the protection of the public. The fact that licensing proved also of benefit to the legal profession itself has never been counted objectionable. Public welfare also demanded the licensing of physicians. This licensing was a godsend to the public and proved a great uplift to the profession.

"The public trusted each of these two professional groups of law and medicine to administer its own licensing law with proper regard to public interest. Shortsightedness and failure to completely keep this trust has already cost the legal profession parts of its field of activity. Judicial procedures have been replaced by arbitration boards in many activities. Administrative boards in many lines are crowding lawyers out. It is to be noted, too, that failure of the medical profession to see fully its responsibility to the public, particularly to the poor, is resulting in a serious threat of socialized medicine. Physicians can combat this threat only by actively recognizing their public responsibility. It is to be hoped that this recognition is not coming too late. It is a well-established fact that no group can remain selfish and continue to retain power and influence long.

"Up to the present time the engineer is trusted by the public. He is known to be trained in the fixed laws of nature and in the greatest respect for them. His training is founded in honesty and in the highest ideals of service. He is thoroughly trusted to hold his profession to high standards. The force of law is placed in his hands to do this. It must be done well. The members of his registration boards are awake to this responsibility. Evidence steadily comes to them of fraud, incompetency, and violation of ethics. In this age of high-pressure fighting for advantage, the engineering profession cannot hope to avoid contamination of evil, without watchfulness and effort. Unity in thought and planning is necessary for this. There should be no disaffection in the family of engineers. The moral and ethical influence of the engineering societies combined with the force of law exercised by registration boards should keep engineering on the high plane where it can render the greatest service and

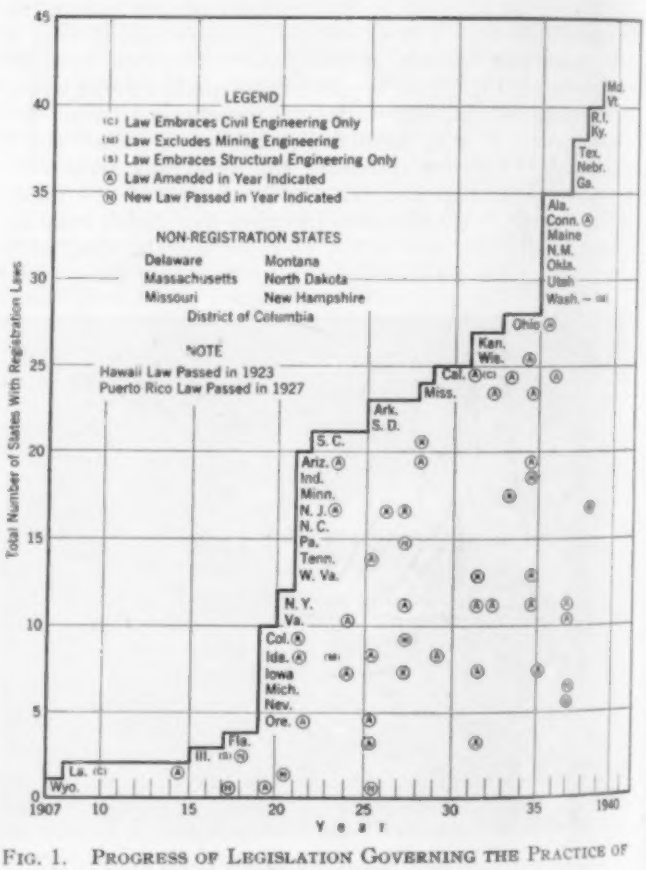


Fig. 1. Progress of Legislation Governing the Practice of Engineering

that attained through graduation from an approved four-year the legal registration of professional engineers, serving

earn and hold the highest respect and trust of the public. The mechanism for achievement is in the engineer's hands. He should make it function smoothly. It is a complete unit. Divided, it would fail. It must be kept complete; then the engineering profession can not only serve civilization in material ways as it is so abundantly doing, but be most effective and at the same time set the highest examples in matters of social organization."

The registration of engineers would have been more effective and of greater benefit to the public and to the profession had everyone concerned concentrated his efforts toward adoption of a general procedure for registration, reasonably high standards of qualification, and a fair scope of application or exemption.

The importance of a general knowledge of the fundamental principles of engineering—and what is sometimes more important, good judgment and common sense—is recognized by all, but it is not generally agreed that it is necessary to require each applicant for registration to have qualifications he may never need, or experience in a field of work in which he may never be engaged.

It seems desirable that the requirements and standards of qualification and of examinations for engineering registration be kept within reasonable limits, not too high to be attainable by the engineer of acceptable ability and not so low as to endanger professional competency. C. Julian Oberwarth in a statement regarding the reciprocal registration of architects uses the following expression, which seems to apply also to a satisfactory procedure for the registration of engineers: "The plan must embody something in the nature of a good sieve, with a mesh that would freely pass a really 'fine' man and stop the 'unfinished' or 'coarse' products."

There is a small group that is still opposed to registration for any members of the engineering profession. There are also some members of one or two branches of the profession who are in favor of registration for certain classes of engineers, provided that they themselves are not included. Then there are those who want all engineers registered, and who maintain that no one should be classified as an engineer unless he is legally registered.

It is believed that a large majority of state board members and of the engineering profession favor reasonable requirements and scope of application of registration laws, and that the extremes advocated by certain groups will probably never be indorsed or accepted by the states or by the profession.

State engineering societies and local sections of national societies have a real opportunity and obligation to render a definite service to their members and to the public, by assisting and cooperating with state boards and committees on registration, so that full benefit and protection may be derived from engineering registration.

ACTIVITIES RECOMMENDED FOR ORGANIZED ENGINEERS

The writer has suggested that state engineering societies and local sections of national societies could well participate in the following activities:

Legislation. They should promote and direct legislative bills and amendments that provide comprehensive registration laws for the protection and welfare of both the public and the engineering profession.

Personnel of Boards. The members of state boards of registration should be nominated by the professional engineers of the state and supported against undesirable political influence.

Enforcement. Violations of the law should be reported and assistance given in prosecuting cases.

Finances. Registration and renewal fees paid by engineers should be retained by the board and used only for the administration and enforcement of the law, and for contributions to the national fund for the coordination and improvement of registration procedure. State and national engineering societies should advocate this policy and oppose diversion of engineering registration funds.

The Committee on Registration of Engineers of the American Society of Civil Engineers has urged the appointment of Local Section committees on registration, and 45 Local Sections of the Society have reported the appointment of such committees. The Society's Committee on Registration is inviting other national societies to appoint similar committees in the various states and has suggested cooperation between registration committees of the different national societies.

In 1929 the National Council recommended to the American Society of Civil Engineers that its Committee on Registration of Engineers be authorized to compile a Model Law for the Registration of Professional Engineers and Land Surveyors, with the collaboration of the National Council and of national engineering societies. A series of conferences, attended by representatives of a number of engineering societies, was held and all provisions of a registration law were considered. On April 15, 1932, the model law was approved and recommended to states, societies, and committees "as a model to be followed in the framing of all new registration laws and the amending of existing laws." This model law was not changed until the spring of 1937, when three conferences were held at which some amendments were made. Previous to the adoption of the 1937 revised draft of the model law, it had been submitted to state boards, engineering societies, and individuals for suggestions and comments. Therefore this approved model law may be considered to represent the consensus of those experienced with, and most interested in, the registration of engineers. Although differing in some parts from it, approximately half of the existing registration laws are based on this approved model law.

PRINCIPAL FEATURES OF APPROVED MODEL LAW

The principal features of the approved model law are:

Definition—Professional Engineering

The practice of professional engineering within the meaning and intent of this Act includes any professional service, such as consultation, investigation, evaluation, planning, design, or responsible supervision of construction or operation, in connection with any public or private utilities, structures, buildings, machines, equipment, processes, works, or projects, wherein the public welfare, or the safeguarding of life, health or property is concerned or involved, when such professional service requires the application of engineering principles and data.

General Requirements for Registration

Section 12.—The following shall be considered as minimum evidence satisfactory to the Board that the applicant is qualified for registration as a professional engineer, or land surveyor, respectively, to wit:

(1) As a professional engineer:

Engineers—Graduation Plus Experience

a. Graduation from an approved engineering curriculum of four years or more in a school or college approved by the Board as of satisfactory standing; and a specific record of an additional four years or more of experience in engineering work of a character satisfactory to the Board, and indicating that the applicant is competent to practice professional engineering (in counting years of experience, the Board at its discretion may give credit, not in excess of one year, for satisfactory graduate study in engineering); or

Engineers—Examination Plus Experience

b. Successfully passing a written, or written and oral, examination designed to show knowledge and skill approximating

that attained through graduation from an approved four-year engineering curriculum; and a specific record of eight years or more of experience in engineering work of a character satisfactory to the Board and indicating that the applicant is competent to practice professional engineering; or

Engineers of Long-Established Practice

c. A specific record of twelve years or more of lawful practice in professional engineering work of a character satisfactory to the Board and indicating that the applicant is qualified to design or to supervise construction of engineering works and provided applicant is not less than thirty-five years of age.

Reciprocity

Section 19.—The Board may, upon application therefor, and the payment of a fee of ten dollars ($10.00), issue a Certificate of Registration as a Professional Engineer to any person who holds a Certificate of Qualification or Registration issued to him by proper authority of the National Council of State Boards of Engineering Examiners, or of the National Bureau of Engineering Registration, or of any State or Territory or Possession of the United States, or of any Country, provided that the requirements for the registration of professional engineers under which said Certificate of Qualification or Registration was issued do not conflict with the provisions of this Act and are of a standard not lower than that specified in Section 12 of this Act.

Saving Clause

Section 22.—This Act shall not be construed to prevent or to affect:

Employees and Subordinates

(*d*) The work of an employee or a subordinate of a person holding a certificate of registration under this Act, or an employee of a person practicing lawfully under Paragraphs (*b*) or (*c*) of this Section; provided such work is done under the direct responsibility, checking, and supervision of a person holding a certificate of registration under this Act or a person practicing lawfully under Paragraphs (*b*) or (*c*) of this Section.

The American Institute of Electrical Engineers published and distributed, during the past year, a "Draft of Model Law for Registration of Professional Engineers and Land Surveyors," which appears to be a new one; however, it is stated in the Preface of the A.I.E.E. draft: "The essential difference between the June 1, 1939, A.I.E.E. draft and other drafts is in the scope of application of the law as to exemptions and in the definition of professional engineering." The National Council Committee on Legal Procedure has been instructed to study the A.I.E.E. draft and report to the next annual convention.

The 1939 annual report of the Committee on Registration of Engineers of the American Society of Civil Engineers contained the following statement:

"*A.I.E.E. Model Law.* The members of the Committee have given this proposed law careful study and have reviewed the opinions of others. This draft copies, with a few changes, the Model Law that has been adopted in many states. The most significant departure from the established Model Law has for its obvious purpose the exemption of most electrical engineers from the requirements of legal registration, since the proposed law exempts all engineers who are 'not for hire to the public and not in public employment.' We do not believe that all engineers in industry should be exempt."

The National Council of State Boards of Engineering Examiners is an advisory and coordinating agency established primarily to assist state boards of registration for professional engineers in a more efficient and uniform administration of state registration laws; and its functions and activities include the certification of engineers, jointly with state boards, for reciprocal registration in the various states, and the operation of a national clearing house and information bureau for matters pertaining to the legal registration of professional engineers, serving state boards, state committees, engineering societies, individual engineers, and the public.

The National Council was organized on November 8, 1920, and will celebrate its twentieth anniversary at the annual convention to be held in Charleston, S.C., on October 28–31, 1940. The membership of the National Council now consists of 43 member boards, which are legally constituted boards of registration for professional engineers. These member boards represent a total of over 65,000 registered professional engineers and land surveyors.

The National Council publishes the proceedings of its annual conventions with other data in its year book, and also publishes quarterly *The Registration Bulletin.* A convention is held annually, the location being rotated among the four zones into which the Council membership is divided.

The National Council has been an active participant in the Engineers' Council for Professional Development since its organization and endeavors to cooperate with all state and national engineering societies.

The National Bureau of Engineering Registration is operated as a function of the National Council of State Boards of Engineering Examiners, under the direction of a standing committee of the Council, with an Advisory Board of representatives from national engineering societies. It was established primarily to minimize the effort and expense of engineers practicing in more than one state in securing interstate registration. The Bureau also constitutes a clearing house for state registration authorities, employers, societies, and others, acting as a reliable source of verified information regarding the professional records of engineers. The Bureau is a nonprofit agency and the fees charged represent only the actual cost of clerical work, printing, and postage.

ADVANTAGES OF CERTIFICATION BY NATIONAL BUREAU

The question may be asked: "Why is certification by the Bureau desirable and why not grant reciprocal registration to any engineer who is registered in another state?" For ordinary state registration an engineer may possess qualifications that meet the minimum requirements for registration under the "grandfather" clause of the state law (or that are adequate for local conditions) and therefore be given state registration; whereas national certification by the Registration Bureau requires an independent verification of an engineer's entire record, evaluation, and certification as to meeting the minimum requirements of the approved model law (not the "grandfather" clause), a review (examination if required) by his own state board and a specific indorsement, recommending him for registration in other states.

Under the Constitution of the United States there can probably be no national registration in any profession, the authority to legally register or license citizens to practice a given profession being vested in the several states. Certification by the Bureau, therefore, is not a prerequisite for registration in any state, nor is it binding upon the state boards of registration, nor does the Bureau assume any responsibility to the applicant in securing his legal registration authorizing the practice of engineering. The by-laws of the National Council and the registration laws or regulations of most states specifically provide, however, for acceptance of certificates issued by the Bureau, and all but four of the member boards of the National Council have definitely indicated that they will accept certification by the Bureau, with indorsement by a state board, as competent evidence of qualification for registration.

than true trans- portation pur-

munities and certain heavily traveled trunk lines are the points at which trouble is centered. During this

Trends in Modern Highway Practice

By Murray D. Van Wagoner

Member American Society of Civil Engineers
State Highway Commissioner, State Highway Department, Lansing, Mich.

In this broad survey of highway problems, Mr. Van Wagoner draws upon data developed by nation-wide governmental studies, as well as by surveys in his own state. Most important, he holds, is the choice of critical road situations demanding first relief. The type of layout often is determined by its safety in terms of traffic density. In Michigan, considerations of traffic and accidents point to those highways in and around urban areas as most in need of improvement. Frequently bypass or express highways contribute social as well as economic advantages. Whatever the basis of judgment—whether operation, maintenance, or replacement—financial factors must be the prime consideration guiding the engineer to the most advantageous type of development.

Perhaps the most powerful influences in shaping American highway practice have been the motive force of increasing traffic and the braking effect of fiscal limitations. In less than 40 years, the number of motor cars has grown from practically zero to 30 millions of registered vehicles, and motor travel has increased to 250 billions of vehicle-miles annually. Year by year, the maximum potential vehicle speed has risen and is now above 80 miles an hour.

Very early, economic processes and habits of life began to be geared to highway transportation service. Today there is hardly an activity of industrial and agricultural production, of distribution and merchandising, or of recreation that is not dependent to some degree on highway travel. Practically all the essential contacts and services of community life are made possible by the highways. This increasing use of the automobile created a demand for adequate roadways which is still growing.

Throughout the period of highway development, however, the amount of funds available has been a limiting factor, and more recently changes in the sources and distribution of highway revenues have brought about a very critical situation. General revenues have been steadily withdrawn from highway support, and motor-vehicle revenues have been spread more and more widely over the entire road and street mileage. A considerable part of the latter funds has been diverted from highway use.

Several states have stopped diversion by constitutional amendments but there is no sign that local support of local roadways will be completely restored or that the mileage of highways and streets over which motor-vehicle revenues are now distributed will be materially decreased. As for increasing revenues by raising motor-vehicle tax rates, the fact that half our car owners have an income of $1,500 or less indicates that such a policy would be unproductive if carried beyond reasonable limits.

However, it seems possible that we are now on the threshold of a more stable period of development. Not that traffic has ceased to grow—the prediction is made that traffic will double in the next twenty years—but certain patterns and trends have appeared which it is believed will persist.

Widening of Woodward Avenue, Detroit, Completed, with Traffic Capacity Greatly Increased

Probably the most potent influence in laying a sounder foundation for highway policy and practice is the practically nation-wide study being made by the highway planning surveys. Cooperatively sponsored and directed by the U.S. Bureau of Public Roads and the highway departments of 46 states, these projects have dug out the facts about highways, their traffic, and their financial support. As the analysis of these data proceeds, the outlines of the highway job are becoming clearer; its most important problems are being classified and examined; and solutions for many of them are in the making.

The first requirement of sound highway development is the determination of those portions of the roadway system on which the expenditure of available highway revenues will best serve the purposes for which they were collected. The present tendency to withdraw all support from the highways except that derived from motor-vehicle taxes, points to the car owner as the one who should properly be benefited.

Total highway needs may be expressed in terms of the financial outlay required to keep intact the existing three million miles of highways and streets. In general these critical highway needs will exist on the motor transport system made up of primary and secondary roadways regardless of what jurisdiction these roadways may be under. We must think in terms of a physical operating plant and not in terms of the units of government that may by accident or otherwise be responsible for its various elements.

The principal objective of highway planning should be to determine primary and secondary roads and streets having the utmost of significance in motor-vehicle transportation regardless of whether they are under the jurisdiction of the city, the county, or the state. Obviously a great many miles of purely local roads and streets, where no traffic problems exist, must be excluded from consideration.

It should be remembered that the motor-vehicle owner pays his license fees and his gasoline tax for the same purpose that he owns an automobile—that is, in order to participate in the benefits of the transportation service afforded by the motor vehicle and the motor-vehicle roadway. He may use his car for other

divided roadways on their first mile. One divided high-

Treatment of Michigan Superhighway
Cutoff Carries Detroit-Pontiac Route
Around Birmingham

than true transportation purposse just as he may sometimes light the stove with his cigarette lighter, but these are not the purposes for which he owns and maintains these devices. For the most part, he would still walk to the corner drugstore and still take the street car to the office were it not for the auto in the garage which he keeps for what he regards as the more significant transportation service.

Interpreted in the light of these provisos, the distribution of travel on various classes of roads in 17 states is of value in determining which roadways are of greatest service to transportation. The Bureau of Public Roads presents the following figures:

System of Roadways	Percentage of Total Road Mileage	Percentage of Total Road Travel
Trunk lines, rural and urban	16%	60%
Local city streets	6%	30%
County and local rural roads	78%	10%

In Michigan, our highway planning survey showed that 14% of the rural trunk-line mileage carried 44.5% of all trunk-line travel; that 55% of all urban vehicle-miles were produced on streets which are the urban connections of federal and state highways; and that 10% of non-trunk-line rural roads carry nearly 60% of non-trunk-line rural travel.

It is on these heavily traveled rural routes and urban arteries that the revenues from motor-vehicle taxes will for the most part be expended under a just and rational highway plan. It is a mistake to believe that to concentrate effort on a strategically selected system rather than to spread it over the total road mileage will work any hardship to traffic. In the one case actual highway benefits are widely and intensively provided; in the other, highway utilization may be just as great, but the benefits are of a much lower order.

Traffic accidents are very properly a subject of great public concern, and highway authorities are naturally giving highway safety a large share of their attention. We are building highways for the average drivers behind the wheels of the nation's automobiles and not for a select group of highly skilled and disciplined motorists. There is no exact way of determining just what proportion of accidents charged against recklessness or carelessness is due, in the last analysis, to ill-judged or unskilled attempts to cope with inadequate roadways or roadway equipment.

A study of fatal accidents in Michigan during the past four years has made it evident that the urban communities and certain heavily traveled trunk lines are the points at which trouble is centered. During this period city streets, producing fatal accidents at the rate of 0.2 deaths per year per mile of streets, accounted for 47% of all such mishaps. Rural roads produced 53% of the state's fatal accidents at the rate of 0.026 deaths per year per mile of road.

Probably because in urban areas the problem is more concentrated and therefore subject to better control, the cities' share of all these accidents has declined from 59 to 47% since 1934. The simultaneous increase in the portion of the accidents occurring on rural roads is probably due partly to the greater volumes and speeds of traffic on the main trunk lines and partly to the type of development in the areas just outside city borders.

Where Most Fatal Accidents Occur

In its exhaustive study of fatal accidents, the Michigan highway planning survey has revealed that suburban sections of trunk lines are the rural "hot spots." Typical results are shown in Fig. 1. More than half of all rural trunk-line fatal accidents occur within five miles of towns of 2,500 or more population. Concentration increases toward the city (Fig. 1). The one-mile zone, containing only 12.3% of rural trunk-line mileage, accounts for 28% of all rural trunk-line fatal accidents. In most cases the larger the city, the heavier is the proportion of accidents in this zone. When all cities are considered, the second-mile zone produces about half as many of these serious crashes as the first, and from that point outward the number tapers off gradually to normal rural frequency.

There are heavy traffic volumes on these suburban sections and, as we all know, it is traffic that produces accidents. But other conditions operate in these areas not only to create more travel but to make travel more hazardous. The subdivision of land bordering the cities has brought urban development, population, and activity into rural sections without providing the traffic facilities or controls that are present in the cities themselves. Quite naturally, this development is found in its most intense form adjacent to the main trunk-line routes.

The record of the numbers and kinds of accidents on these close-in sections of the trunk lines suggests what their needs are. The fact that 34% of all trunk-line accidents involving a pedestrian fatality occur within the first mile, indicates that consideration must be given to sidewalks and to highway lighting in some of the most critical areas. Concentrations of vehicle collisions at an intersection give strong hints that a grade separation is required. Where serious accidents reach a high frequency between intersections it is good evidence that the capacity and perhaps the type of the pavement is unsuitable for its traffic.

In this connection, it is interesting that accidents between intersections were found to be less concentrated in the one-mile zone about Detroit than elsewhere. This is believed to be because one-third of the trunk lines have

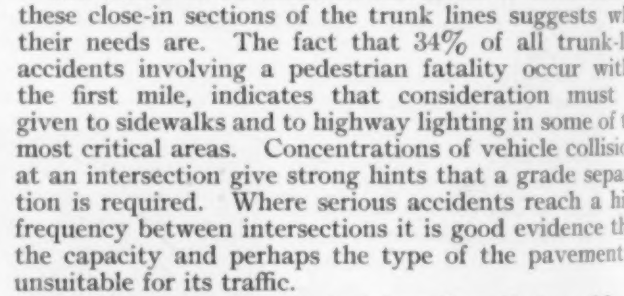


Fig. 1. Record of Total Annual Fatal Accidents Outside City Limits for Michigan Cities of 10,000 to 25,000 Population

Thus it may be expected that in addition to providing facilities needed for safe driving, the development of these efficient streets will remove some of the condi-

more than 30 miles in length, and 25% were in excess of 260 miles. On US-24, leading from Detroit to Toledo, similar tendencies were evident. It is clear that with-

divided roadways on their first mile. One divided highway, which traverses 14 miles of densely settled suburban territory toward Pontiac, has maintained a record of from 3.6 to 4.1 fatalities per 100 million vehicle-miles during the last three years. By contrast the same highway north of Pontiac, a four-lane undivided roadway, had a fatality ratio in 1936 of 19.8 deaths per 100 million vehicle-miles.

Analyses of accident occurrence (Fig. 2) also give very definite information as to the volumes of traffic that can be safely accommodated on divided highways and on pavements of 2, 3, and 4 adjacent lanes. These indicate that the two-lane pavement is satisfactory for average traffic loads up to 3,500 cars a day. Similarly, the three-lane pavement is fairly adequate for average daily volumes of from 3,000 to 5,500 vehicles. In no volume range is the four-lane highway safer than the other two undivided pavements and in most ranges it is definitely more hazardous. By contrast, the divided highway revealed an insignificant fatal-accident rate under all volumes observed. These results aid in determining not only the suitable type of pavement for existing traffic, but the stages by which the roadway should be expanded for traffic growth.

Width of lane is of hardly less importance to highway safety than number of lanes. Observations have led to the conclusion that the ordinary 10-ft lane is too narrow for highways carrying large volumes of traffic. This is even more true where there are many large-dimension, slow-moving units. Under these conditions, the minimum over-all width of two lanes carrying one-directional traffic should be $23^1/_2$ ft whether on a divided roadway

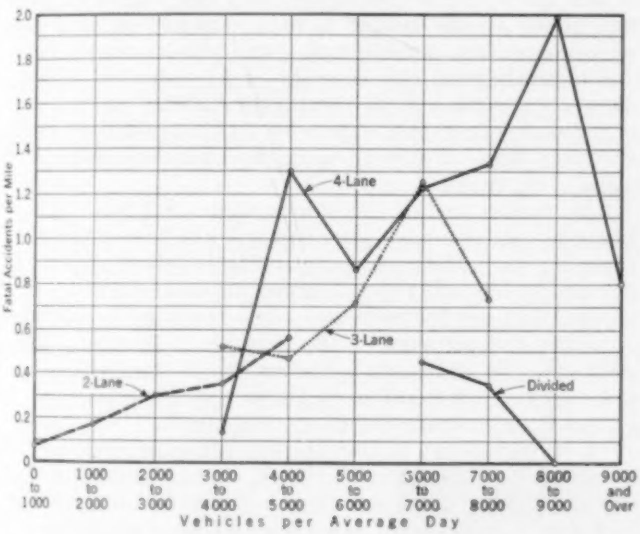


Fig. 2. Annual Fatalities Between Intersections, Excluding Pedestrians, on All Hard-Surfaced Roads in Michigan

or on half of an undivided four-lane pavement. The added width should go to the left-hand or inside lane, since it is there that the critical overtaking and passing maneuvers of the faster cars take place.

Real progress is being made in the task of finding and dealing with the causes of accidents. Sometimes, however, we who are in the fight to prevent or control them are too apt to ignore the possibility that there may be other factors at work. A study of traffic fatalities in Michigan over the past 15 years has revealed that the economic cycle has a potent influence on their occurrence. A graph (Fig. 3) discloses that while volume of travel and fatalities are usually closely correlated, traffic deaths rise and fall with employment. The reason is

Shore Highway with Planted Side Slopes
Stretch Is Between Manistique and Thompson in Upper Peninsula of Michigan

that the driver in the lower income brackets, who is shown by the record to be most often involved in accidents, is most sensitive to changed business conditions. Thus, in bad times, marginal cars and marginal vehicle-miles are in part removed from the road. Further, there must be a strong pressure on all motorists to drive with greater care, as shown by the fact that gas tax receipts are comparatively little affected by slack employment. Return of industrial activity boosts gas consumption to new high levels and results in another spurt in the fatality toll.

There is something beside a caution against over-confidence and over-optimism in these relationships. They also point to the rapid growth of highway travel in spite of all handicapping conditions and to the responsibility that rests on the highway agencies to provide for and to protect this traffic, particularly during periods of increasing business activity.

Without forgetting the very real needs of much of the trunk-line and secondary mileage of the country, we must remember that inadequacy is greatest in the larger urban centers and radiates in diminishing intensity from them. Numerous indices prove this. Areas where car ownership and heaviest traffic volumes are concentrated have the highest fatal accident rates; and the gradual deterioration of business activity and property values occurs where transportation service is deficient.

The enormous proportions of the movement of vehicles on the principal urban arteries, the importance of this movement to the life of the city, and the blocking effect it causes at intersections—all indicate that special facilities must be built to handle it. Widening operations give relief but the relief is only temporary, and in time the easier access to already crowded districts increases the basic difficulty. Unquestionably the only real solution will be found in the construction of depressed or elevated limited-access streets to, through, and around the sections of highest commercial and traffic importance.

These modern arteries will traverse areas which urban growth and lagging transportation service have blighted. Such areas exist in every great metropolitan center, and the development of broad adequate channels for traffic will not only correct the faults that created them, but will be a powerful influence in restoring them to usefulness and prosperity.

A recent traffic survey of Detroit disclosed that these blighted areas contain districts in which are concentrated the car owners most frequently involved in accidents.

Servicing a Modern Airport

Thus it may be expected that in addition to providing facilities needed for safe driving, the development of these efficient streets will remove some of the conditions which produce bad drivers.

Indicated as the logical routes for this metropolitan construction are the urban extensions of trunk lines—which carry more than half the urban travel—and certain other arteries that connect with or relieve them. The Michigan data reveal that for all municipalities in the state, the traffic entering and leaving on trunk lines

Railroad and Highway Grade Crossings Eliminated Where U.S. Routes 12 and 24 Intersect in Dearborn, Just West of Detroit

equals 48.2% of that on the trunk-line streets. Further, the ratio varies in inverse proportion to the size; in cities of more than 100,000 population, it is 48.3%, while in towns of less than 1,000 population it is 81.3%.

These percentages, together with the proportion of trunk-line traffic units having their origin or destination in urban places, dictate decisions as to bypass and belt-line construction on the rural system. Since the larger cities are the termini of a larger proportion of trips, and since these studies show that trunk-line travel makes a proportionally smaller contribution to the traffic on their trunk-line streets, the problem appears to be to provide access rather than through facilities. However, there often is need to build belt lines to distribute trunk-line traffic to its proper section of the city before it becomes involved in the heavy volumes of the central district, and also to afford intra-city connections.

The two facts that the bulk of motor vehicles are owned in urban centers and that a very large proportion of all car trips are less than 10 miles in length, indicate that suburban areas carry the heaviest rural travel. Their high accident rate proves their inadequacies.

Here the work of fitting the primary highways for exceptionally heavy use must start. Merely increasing the pavement capacity will answer the purpose in some cases, but many sections of suburban trunk line will require divided roadways; on some, side roads for local travel will be needed; and a few connecting with major metropolitan arteries must be developed as limited-access highways. Construction on the strictly rural sections of primary highways will ultimately be of these same types and will be extended outwards from the urban centers as travel volumes justify.

Data regarding the large proportion of very short trips made by car owners should not be interpreted as indicating a lessened driver interest in trunk-line travel and facilities. On US-112, between Detroit and Chicago, it was found that nearly 85% of trips were more than 30 miles in length, and 25% were in excess of 260 miles. On US-24, leading from Detroit to Toledo, similar tendencies were evident. It is clear that neither the character of the traffic nor the length of trips on such routes will prevent their development as limited-access express ways when and if volume of travel warrants such treatment.

Limits of Practical Development

It is well to keep in mind that highway income must be in the future, as it has been in the past, a controlling factor. Under the immense pressure of a fast-growing motor transportation, funds were provided liberally from the general public purse and from special vehicle charges. With these has been created what is perhaps the greatest highway system the world has known. Because of its great extent, many think the job is done.

This fallacious belief may account for the growth in tendencies to shift motor-tax income from the motor roads to the non-motor system and to non-highway uses. The engineer and the highway administrator know that the highway job will never be done; that the plant brought into existence to serve useful social and economic purposes must be perpetuated by replacements and maintenance, and must be operated. Furthermore, it must be expanded to keep pace with its growing usefulness. The costs of these types of work make up the total annual outlay for the highway system. The future highway development must be attuned to annual outlays within the public's financial ability and willingness to pay.

Adequacy within financial resources must be the engineer's guide. The farsighted highway administrator will guard in the future against building up a system whose operating, maintenance, and replacement requirements are beyond the capacity of its revenues. Such a dangerous expansion of the public liability in highways may take place in two ways—by reckless additions to the system's over-all extent, and by over-development of some of its parts.

The proper use of the information that the highway planning surveys have provided will aid in avoiding both these errors. Data are now available which permit the determination of those highways and streets whose service and productiveness entitle them to be included in either the primary or the secondary system. Other data tell the designing engineer what standard of improvement each section of these roadways requires to enable it to meet the demands of its traffic.

More important in the present phase of highway development, the survey findings contain material that will be helpful in establishing a stable balance between highway benefits and the source and amount of highway support. When such a balance is obtained, it will be found that highway practice is adequate to the task of providing the highest type of highway facilities and service that the public is able and willing to pay for.

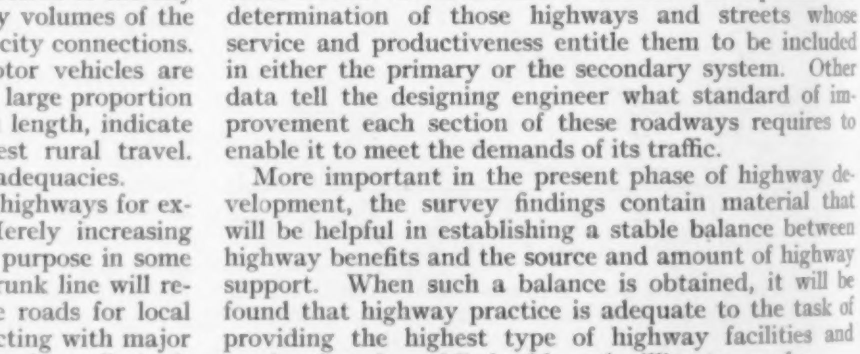


Fig. 3. Relation of Traffic Deaths, Industrial Employment, and Gasoline Consumption in Michigan, 1930–1938

Servicing a Modern Airport

Myriad Appliances, Controls, and Supply Systems Provided for LaGuardia Field, New York, N.Y.

By Brehon B. Somervell

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In his preceding article, Colonel Somervell described the development of LaGuardia Field from an inconspicuous private airport into one of the outstanding air terminals of the United States. In the present paper, he supplements that general study with interesting details of some of the correlated facilities—such as the heating, lighting, drainage, fire-prevention, and communication systems—which together make up this busy and complex development. This account deals with a complicated problem, involving many fields of engineering endeavor, which was solved by a broad understanding of the principles of design plus meticulous attention to details. Originally this material was presented before the Waterways Division at the Society's 1940 Annual Meeting.

Despite its simplicity in outward appearance, an airport is a complicated thing at best. It may look like a plain field with a few paved roadways, served by garage-like buildings. Actually it is a closely integrated, carefully designed unit of transportation.

General features of LaGuardia Field, new municipal airport recently opened in New York City, were described in the April issue. (See especially Fig. 1 of that article, which will be referred to herein.) This paper covers some of the many facilities, mechanical and otherwise, that make this huge mechanism "tick"—evenly, continuously, dependably, and comfortably.

Among the more spectacular elements, from the standpoint of magnitude, are the electrically operated steel-and-glass hangar doors, enclosing the seaplane hangar building on four sides, and all the land-plane hangars on the field side. These doors are hung in pairs, and in the case of the land-plane hangars can be opened so as to provide a clear space 163 ft 5 in. wide and 42 ft high, comprising one-half of the total door opening for the hangar. Each door, weighing approximately 25 tons, is in two horizontal sections. In opening, the lower half rises inside the upper half until even with it, providing a 21-ft opening; then, if desired, the two sections swing out and up together to a horizontal position, leaving the entire 40-ft opening clear, and providing a canopy approximately 20 ft wide over the door opening. These doors can also be operated by hand in case of an emergency, a system of counterbalances taking up the weight. The exterior space between the top of the doors and the flat curve of the roof is covered with stainless steel, and the corresponding space at the opposite side of the building between the roof of the two-story wing and the hangar roof, is a huge window, glazed with blue glass, which reduces the heat and cuts down the glare.

Provision is made for bringing gasoline to the airport by water in barges and discharging it directly into storage tanks by pipe lines. At the westerly edge of the field near the bulkhead is a building housing eighteen 20,000-gal storage tanks with the necessary pumps, foamite equipment, and loading apparatus (Fig. 1). Gasoline is pumped into these tanks direct from the barges at the bulkhead. This building will serve the seaplane hangar by pipe line. From stations outside, trucks will load to serve the hangars at the easterly end of the land-plane area. A separate gasoline storage building for Hangars 1, 3, and 5, just west of that group, has seven 15,000-gal tanks with all the necessary equipment. The tanks also receive their gasoline through pipe lines from the Bowery Bay barge connection, and distribute it through underground pipes to fueling pits in front of the hangars.

In its initial state the airport comprises seven huge hangars and two administration buildings, apparently ideally adapted to the use of central heating. Extended studies, however, revealed that individual heating of each building would prove far more economical and satisfactory. A central heating plant would require miles of underground high-pressure steam mains, difficult and costly to maintain. It would also require a large personnel to operate and maintain the plant and to supervise the sale of steam.

Details of the Heating System

For large spaces having high ceilings, the direct-fired hot-air system of heating has many advantages. It has the highest operating efficiency, responds rapidly to load demands, is low in first and in operating cost, and combines the functions of heating and ventilation in the same equipment. Hence each land-plane hangar was equipped for such use with four direct-fired, welded-steel-plate, hot-air furnaces having a total capacity of 400 boiler hp. The furnaces are automatically oil fired, using No. 6 Bunker C oil. The seaplane hangar has six similar heaters.

Control Tower Atop Land-Plane Administration Building—Nerve Center of Airport

Shutters Folded Against Visor Can Be Turned Down to Act as Sun Guard

Each furnace has two supply air blowers and one induced-draft fan on a common shaft driven by a 25-hp motor. The four furnaces deliver 135,000 cu ft of heated air per minute to the heating systems. Each furnace with its fans and burners is a separate unit electrically interlocked with the necessary controls and safety devices to the adjoining units. The design is an original development and an improvement on the existing smaller-size direct-fired unit

of an elaborate local fire-alarm system interconnecting

INTERIOR OF TYPICAL LAND-PLANE HANGAR, BIG ENOUGH FOR A FOOTBALL GAME

Planes Are 21-Passenger Type of Largest Commercial Ships. Each Hangar Accommodates 14 Planes

heaters commonly used for large-space heating. The number of furnaces in operation at any time is automatically controlled in accordance with the load demand.

The hangar spaces are heated to 55 F and the adjoining shops and shop offices to 65 and 70 F. The system is designed to raise the temperature in the hangar spaces from zero to 55 F in 24 minutes, after the doors are closed. Because of the large door openings, quick restoration of operating temperatures is of primary importance.

In the hangars air is distributed through underground masonry ducts to floor registers located along the side walls and to a continuous grating in the floor just inside of the large hangar doors. Air is recirculated to the heaters through large grilles in the middle of the back wall. The shops are heated similarly. For the shop offices heated air is distributed through a system of metal ductwork. Temperatures are automatically maintained throughout.

For the two large administration buildings, heating is by conventional two-pipe low-pressure steam systems with vacuum return. All radiators are automatically controlled by a pneumatic temperature control system. Each building has its own low-pressure steam-boiler plant consisting of two welded steel boilers, automatically oil fired with No. 6 Bunker C oil.

In Hangars 1, 3, and 5 (Fig. 1), leased by the American Airlines, the lean-to buildings were increased in size and designed to serve as main offices, completely air conditioned for summer and winter weather. Hot air was not suitable and a separate low-pressure steam heating plant was therefore provided in the central hangar, No. 3, using a two-pipe low-pressure system with vacuum return. All radiators are thermostatically controlled.

For air conditioning, 22 units are supplied with chilled water from a central refrigerating plant in Hangar 3, containing four 50-ton Freon compressors, two water coolers, and four condensers. A second refrigerating plant of 100-ton capacity, serving non-office spaces, is located in the test shop building adjacent to Hangar 5.

The electric light and power systems for the airport are supplied by the Consolidated Edison Company from its high-tension network. There are two services to each building—"A" and "B"—balanced so that if one service fails the entire building will not be crippled—merely half of it.

Current comes in at 27,000 v to transformer vaults, one in the Land-Plane Administration Building for that building only, one between Hangars 3 and 5 for Hangars 1, 3, and 5, and one between Hangars 2 and 4 for Hangars 2, 4, and 6. The seaplane base has one transformer vault in the seaplane hangar serving both buildings.

In these transformer vaults the service is stepped down from 27,000 v to 120/208 v, 3-phase, 4-wire secondary service. Adjacent to each vault is a switchboard room for distributing services "A" and "B" to the various buildings, each having its own distribution switchboard.

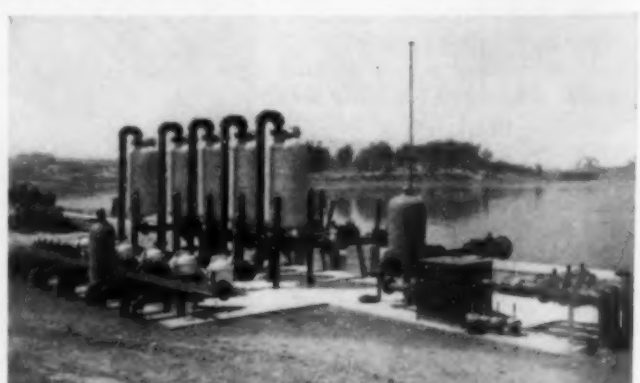
The field lighting—including flood, boundary, obstruction, and other lights—is fed from an independent system. Its transformer vault is in the Land-Plane Administration Building.

For drainage, a subsurface system takes care of the ground water and a surface system drains off the storm water. The subsurface system is complete for the apron and runways, and crossovers have been installed under the runways so that surface drainage for the field can be installed at any point, at any time, and not interfere with traffic.

The subsurface drainage system, designed to lower the ground-water table, comprises broken-stone trenches and 6-in. perforated corrugated iron pipe on each side of all runways and taxiways. The water flows into junction basins, about 400 ft apart, and is carried off through concrete and vitrified tile pipes ranging from 8 to 36 in. in diameter, emptying into the river and the two bays through 14 outlets that are spaced around the perimeter of the field.

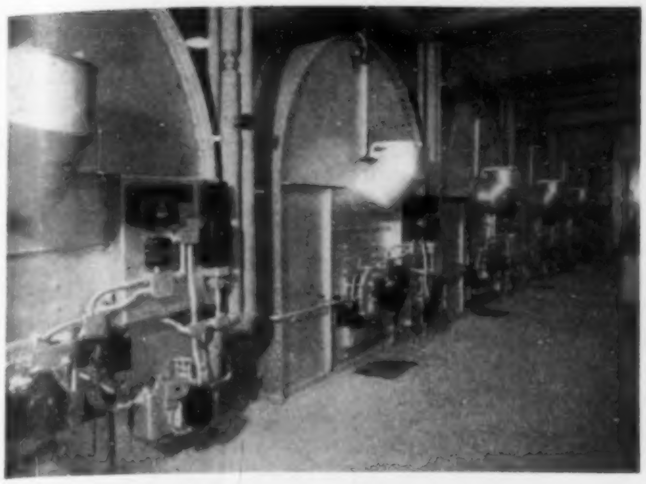
Drainage for storm water is designed for a runoff of 1 in. per hour, about double that required for most hard storms in this neighborhood. Brick catch basins $3^1/_2$ to $4^1/_2$ ft in inside diameter, and from 4 to 12 ft deep, are located about 200 ft apart along the edge of the apron and roadways. These drain into the same pipes that carry the ground water to the river.

Sanitary sewers connect all buildings with the new city sewer running across the southwest corner of the field and emptying into the disposal plant being built by the city to the west of the airport.



DETAIL OF INTAKE GASOLINE LINES, NEAR SEAPLANE BASE

Gasoline Is Pumped from Barge Through Upright Filters Shown, Then Through Meters to Pipe Lines and so to Storage Tanks



HEATING FOR SEAPLANE HANGAR BUILDING
Battery of Six Oil-Fired Hot-Air Furnaces, Each of 100-Hp Capacity

Water supply for the land-plane base is furnished by one 12-in. and one 16-in. main feeding a 24-in. main; two 12-in. mains feed a 16-in. main for the marine base. The two systems are interconnected by a 16-in. main so that if one fails, the other can supply both bases.

The 24-in. low-pressure line branches at a pumping station located between Hangars 3 and 5, to feed tanks and pumps by an 18-in. line. From the pumping station, a 24-in. high-pressure line, with a pressure of 100 lb per sq in., feeds all buildings in both land-plane and marine bases for fire protection. At seven points along the lines, connections are provided so that in case of failure of the pumping station the New York City Fire Department can build up the high pressure.

Plumbing arrangements include shower rooms in each hangar for the use of pilots and other employees, and men's and women's toilet rooms on each floor of both the land-plane and the marine terminal buildings.

All the buildings are fully equipped with the latest automatic sprinklers. The hangar areas have a deluge system operated by a "rate-of-rise" control, while the office and shop areas of the hangars have a standard wet pipe system, controlled by a variable-pressure alarm valve. The operation of any sprinkler valve will sound a code number, indicating the building on all fire-alarm gongs, will record and time-stamp the code number on the register in the Port Manager's office, and sound a bell in the building in which the operated valve is located. There is a city fire-alarm box in each administration building.

A vast network of underground and interior conduits and cables accommodates one of the most extensive interconnected telephone systems ever laid out for any airport. The main service cables enter the Land-Plane Administration Building, which is the central distributing point for the entire system. Telephone cables are also used for teletypewriters and radio communication. A nation-wide hook-up of teletypewriters supplies information to air lines regarding weather conditions.

The entire airport is protected by means of an elaborate local fire-alarm system interconnecting all buildings by means of a code-ringing, closed-circuit, electrically supervised 120-v a-c system. A crash alarm system with air whistles and a sprinkler alarm system is also connected in. The fire-alarm and crash-alarm systems are supervised from the radio control tower in the Land-Plane Administration Building.

INTRICATE LIGHTING SYSTEM PROVIDED

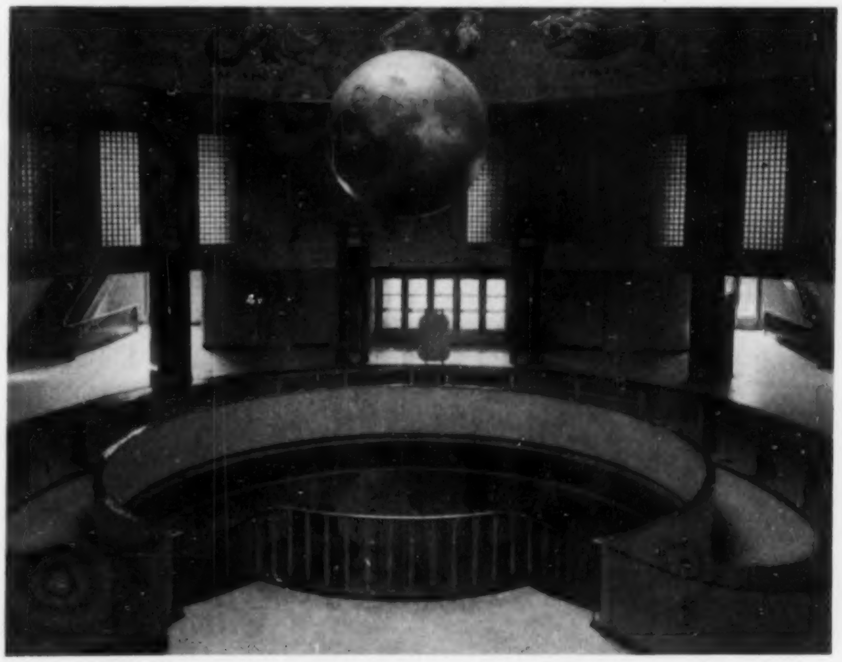
To the pilot of an incoming plane, at night, the field will appear dark, its edge and the runway he is to use outlined by lights, with powerful floodlights operating from the ends of that one runway. Buildings will be marked out for him by red obstruction lights.

Runways are bordered by flush-type contact lights, spaced 200 ft apart. These lights throw two beams along the runway, one horizontal and the other 15° from the horizontal. The brightness of the contact lights is adjusted from the central control tower according to the weather, the operator having a range of three degrees of brilliance to choose from. These lights show white for the first half of the runway and amber for the remainder, with filters so placed that the same rule holds from whichever end the plane approaches.

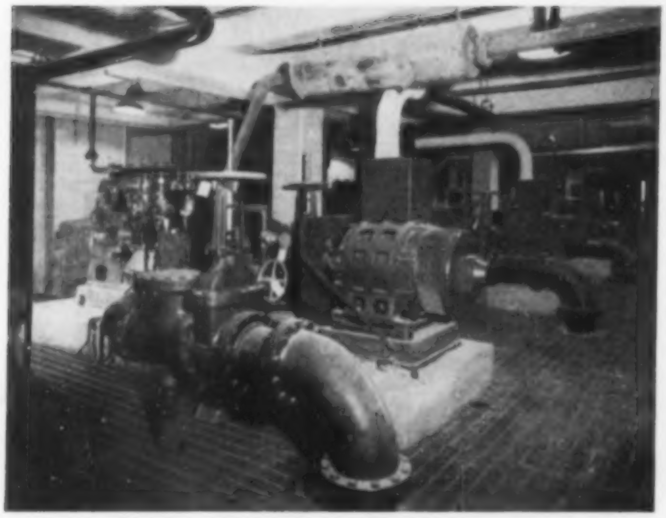
The ends of each of the four runways are marked by cone-type green range lights and provided with two narrow-beam floodlights, each of 7,500,000 cp. Each runway and taxi runway is controlled by red traffic lights, indicating when it is in use. Across the taxi-strips leading to the runways are treadles notifying the control operator that a plane is entering upon or leaving that runway.

The field is outlined by 85 cone-type boundary lights, spaced 250 ft apart. These are amber in color, and of the latest prismatic type, giving a piercing beam. They are alternately connected on two circuits so that if one circuit fails only alternate lights will be affected.

The apron is illuminated by floodlights of which five are mounted on each hangar. The red obstruction lights on top of the buildings are Neon tubes with auto-



LAND-PLANE ADMINISTRATION BUILDING INTERIOR, MAIN FLOOR, WITH INFORMATION DESK
Incoming Doorways Straight Ahead; Circular Stairways Lead to First Floor and Main Outgoing Doors



FIRE PUMPS IN PUMP BUILDING BETWEEN HANGARS 3 AND 5
Each Unit Has 2,000-Gal per Min Capacity

matic switch-overs so that if one tube fails another goes on automatically, and at the same time indication is given to the control operator that a tube has proved defective. When a plane has landed on a runway, the floodlights and runway contact lights go out and the taxi lights go on, showing the pilot the taxi lane by which he is to reach the loading apron.

LIGHTING CONTROL DESK SHOWS AIRPORT IN MINIATURE

The nerve center of this whole network of lights is a desk in the control tower of the Land-Plane Administration Building, which shows the airport in miniature. Tiny lights go on and off with the contact, traffic, and floodlights on the field, and inform the control operator when a plane crosses a treadle in moving to or from a runway. The operators in the tower have the control of the entire field lighting system at their finger tips. Those lights in continual use at night, such as the boundary and obstruction lights and the lights on roads and parking space, also are controlled by astronomical time switches which turn them on at sunset and off at daybreak, subject to the control of the operators.

This intricate and efficient lighting system required the installation of a network of underground cable in ducts covering the entire field. Approximately 800,000 lin ft, or some 160 miles of duct were laid.

Bowery Bay is illuminated by two banks of floodlights so situated that the pilot, whether taxying in or out, will not receive the glare in his eyes. Each of these banks comprises three floodlights of 3,000 w each, or 18,000 w for the two banks. Lighting at the marine terminal, including the terminal building, hangar, and the floodlights on Bowery Bay, is controlled from the terminal and also is tied in with the Land-Plane Administration Building so that the entire airport operates as a single unit.

At the north end of the airport there is a 22-ft wind "T," electrically illuminated for night use, to give the pilot the direction of the wind to aid him in landing. It is connected with an indicator in the control tower as a double check for the operators against readings from the roof of the tower. This wind "T" can also be set by the operator to aid the pilots when the wind velocity on the field is too light to operate it mechanically.

At present, only runway No. 2, the 5,000 ft runway, is equipped for instrument approach. The transmitting station for this is behind Calvary Cemetery in Maspeth, Long Island, 3.4 miles from the southwesterly end of the runway. The system used is known as the SMRAZ-D unit.

When the pilot passes over the transmitting station he receives a high-frequency note informing him of that fact, the note coming from a transmitter known as a Z-marker. Halfway between the transmitting station and the airport is another Z-marker. These two Z-markers give him his exact distance from the runway. From this and his altitude he can compute the gliding angle. This runway is also equipped with approach lights on the southwest end—7-ft neon tubes spaced 200 ft apart and carried across the Grand Central Parkway on a line in extension of the runway for a length of 3,000 ft.

Provision also has been made in the plans for equipping the 6,000-ft runway, No. 1, for instrument landing when a satisfactory system is approved. Auxiliary power outlets for radio, light, or power use are located at each end of all runways.

All radio receivers, including those of the airport itself and those of the air lines, are located on Rikers Island in order to eliminate electrical interference from automobiles and machinery. A 200-pair submarine cable connects the towers on the island with the control tower on the Land-Plane Administration Building, from which distribution is made to the operating offices of the air lines. The radio transmitters for the airport control tower also are on the Land-Plane Administration Building; those for the air lines are located in the marshes of Jamaica Bay, along Cross Bay Boulevard, some 15 miles from the airport and are connected with it by telephone company wires.

Upon completion of the airport all areas not covered by buildings or other construction will be planted and seeded. Such areas comprise approximately 375 acres of planted ground, upon which have been placed 500 trees and 275,000 cu yd of top-soil.

EXTERIOR OF LAND-PLANE ADMINISTRATION BUILDING, PARKWAY SIDE
Main Entrance Doorways, Top of Ramp; Three Main Exit Doorways Below

When the work now under way is completed, on May 1, 1940, LaGuardia Field will be the finest developed airport in the United States. The total cost will probably exceed $40,000,000, about $17,000,000 contributed by the city and the remainder by the federal government.

Room is available for three more hangars and two utility buildings. The City Council has the construction of one of these now under advisement. A hangar and office building for the Civil Aeronautics Authority and a hangar for transient fliers have recently been authorized and work has begun on their construction.

The Tacoma Narrows Bridge

By Clark H. Eldridge

Member American Society of Civil Engineers

Bridge Engineer, Washington Toll Bridge Authority, Tacoma, Wash.

Now nearing completion, the Tacoma Narrows Bridge will provide a long-needed traffic short-cut between the Olympic Peninsula and the metropolitan centers along the eastern shores of Puget Sound. Substructure construction methods and innovations in superstructure design are the outstanding features of the project from a technical standpoint, and both of these phases of the work are covered by Mr. Eldridge in the accompanying article.

The northwest portion of the state of Washington is divided in a north-and-south direction by the waters of Puget Sound which, extending from the Straits of Juan de Fuca inland and south, a north and south distance of approximately 90 miles, separate an area of land about 80 miles in width (east and west) and 90 miles in length from the rest of the state. This area, known as the Olympic Peninsula, is well provided with local highways, but the waters of Puget Sound effect a barrier between it and the rest of the state to the east (Fig. 1). All travel to and from the peninsula is by means of ferries in the vicinity of Seattle and Tacoma or by highways around the southern end of the sound through Olympia.

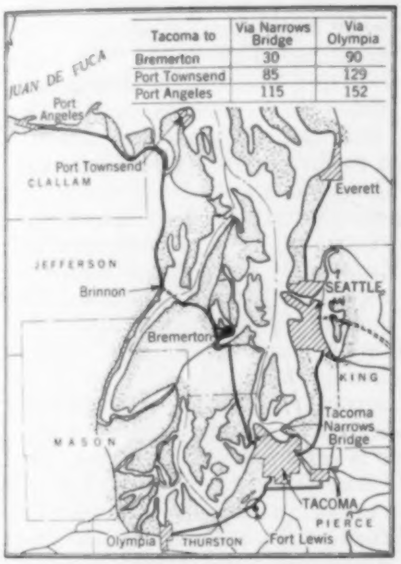


Fig. 1. Puget Sound Area, Showing Tacoma Narrows Bridge and Connections

Puget Sound in the vicinity of Tacoma is restricted at its narrowest point to a width of about 4,600 ft in what is termed the "Tacoma Narrows." The bridging of the sound at this location as a means of more ready access to the Olympic Peninsula has long been proposed; however, because of the great depth of water and the swiftness of the tidal currents, the cost of a bridge was an effective barrier to its financing and all efforts of private individuals in this direction failed. On the advent of the Public Works Administration an application was made by Pierce County, in which Tacoma and the project are situated, for funds to aid in the construction. This effort was also unsuccessful.

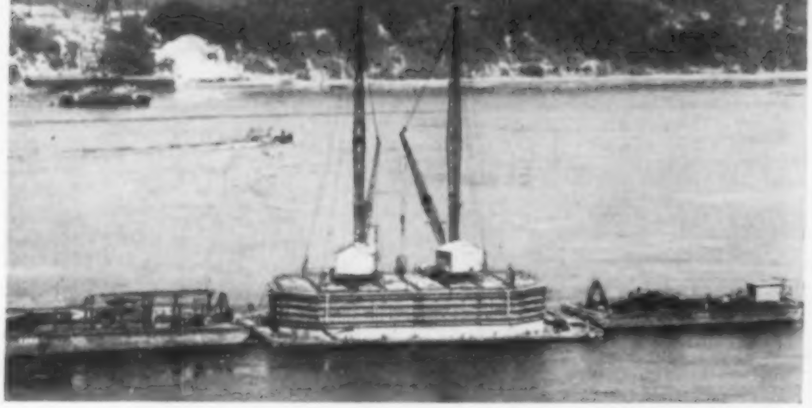
In 1937 the state legislature created the Washington Toll Bridge Authority with the power to finance, construct, and operate toll bridges, and an amended application for a grant was filed with the PWA. Application was also made to the Reconstruction Finance Corporation for the purchase of the revenue bonds to be issued by the Authority providing for its portion of the cost. Both these applications being acted upon favorably during the summer of 1938, the Toll Bridge Authority prepared detailed plans and specifications and on November 25, 1938, executed a contract for the construction.

The plans provide a connection with the city streets in Tacoma on the east and with the existing highway system on the west. The bridge (Fig. 2) consists of a suspension structure with a total length of 5,000 ft, divided between a central span of 2,800 ft and spans on each side of 1,100 ft. Approaches and anchorages bring the over-all length to 5,939 ft. A normal vertical clearance of 196 ft is provided for navigation purposes. The structure provides a two-lane roadway 26 ft in width with a 4-ft 9-in. walk along each side, and is designed to carry the standard H-20 highway loading.

Because of the particular circumstances surrounding the project, unusual features of design and construction were required in both substructure and superstructure. Piers had to be placed in water that attained a maximum depth of 200 ft and moved with a velocity up to $8^1/_2$ miles per hour. Funds limiting the width to only that sufficient for two lanes made it desirable for the sake of lateral stability to keep the central span as short as possible, while the importance of placing the piers in as shallow water as practicable made a long span desirable. The 2,800-ft central span chosen placed the piers in about 120 ft of water and resulted in total depths below the surface of 175 ft for the west pier and 224 ft for the east pier. With the cables 39 ft apart, this gave 72 for the span-to-width ratio.

The entire area consists of glacial deposits of sand and gravel to depths far beyond the elevations to which the piers are sunk. At about the elevation of the surface of the water there is a layer of clay approximately 100 ft thick extending away from the water in a horizontal direction on both approaches. It seems apparent that the channel of the Narrows has been cut through this

Fig. 2. Artist's Concept of Completed Bridge



Excavation in Progress on Caisson of East Main Pier

layer. Piers and anchorages, therefore, have been founded in sand and gravel at such depths that the piers are safe from all possible scour and the anchorages are secure from any danger of sliding.

The main piers have been proportioned for fatigue loads of 12 tons per sq ft from combinations of dead load, live load, temperature, wind, tidal currents, and wave and ship impact. Design stresses in piers and caissons are 900 lb per sq in. for the concrete and 18,000 lb per sq in. for the structural and reinforcing steel. The piers were designed in such a way that they could be constructed as reinforced-concrete bottom-door caissons, 66 ft in width and 120 ft in length. These caissons (Fig. 3) have exterior walls 3 ft 3 in. in thickness, and are subdivided by 24-in. reinforced-concrete cross walls into wells approximating 13 ft square, all cast over a structural steel cutting edge and around a structural steel frame. Bottom doors arranged in the usual manner consisted of two layers of timber, the first of 8 by 12-in., and the second of 4 by 12-in. material, the seams in both layers being well calked. These doors were designed to withstand hydrostatic pressure up to 6,900 lb per sq ft, and in actual construction performed their task with little leakage.

ANCHORAGES FOR CAISSONS A MAJOR PROBLEM

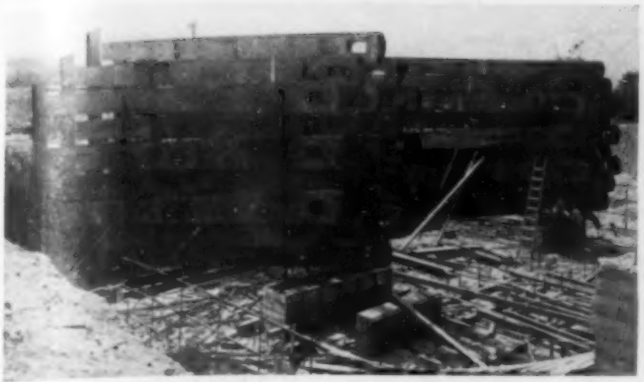
The major problem in pier construction was the anchorage for the caisson in its floating stages. By the specifications, the details of handling this problem were left with the contractors, subject only to a specified loading condition. The adopted anchorage consisted of large reinforced-concrete blocks 12 ft by 12 ft by 51 ft 6 in., weighing approximately 600 tons. Because of the method of placement, the reinforcement of the anchor blocks consisted of 1-in. cables placed on all faces. It was felt that this type of reinforcement would provide more resistance to sudden shock than other types. These blocks were placed around the pier site in a circle of about 900-ft diameter, with the individual blocks located where calculations required.

Constantly shifting currents together with swirling action required substantial anchorage in all directions. The "holding ability" of the individual block was based on its resistance to sliding, taken at 0.4 of the submerged weight after allowance had been made for the vertical component of cable pull. Because of the large forces involved, caisson model studies were made in the hydraulic laboratories of both the University of Washington and the University of California to more accurately determine the "shape coefficient" used in the standard formula for forces from currents. The results of these experiments indicated coefficients ranging all the way from about 1 to 4, depending on the direction of the current in relation to the caisson, and on its draft. However, for a caisson that did not approach too closely to the bottom during a heavy run of the tide, it was concluded that the value of 1.4 assumed in the design gave satisfactory results. Measurements taken of the actual tensions developed in the anchor lines indicated that the forces never approached closer than 50% of those computed.

The anchors were cast on barges at a convenient place for the delivery of materials and towed to the site. The barge was triangulated into position and the block dumped by admitting water through sea-cocks into a compartment along one side of the barge. Inspection made by divers indicated that for the west pier, at which the bottom was fairly level and smooth, the blocks came to rest within 10 or 12 ft of their theoretical positions without damage. At the site of the east pier, where it was necessary to level the site before the caisson could be landed, the bottom sloped quite abruptly, the depth of water being about 50 ft over the shoreward anchors and 200 ft for those on the channel side. Anchors dumped parallel with this slope had a tendency to roll and at times were as much as 75 ft out of position. Also, because of the boulders found on the bottom, several of the anchors cracked. However, after these blocks had been wrapped with cable by the divers, they were proved by pulling tests to be adequate for loads 50% beyond the requirement. Two $1^9/_{16}$-in. anchor lines attached each block to the caisson (Fig. 4). Lower anchor lines were in general fastened to the block before dumping, while the upper lines were made fast by divers.

The caissons were constructed up to the 36-ft height away from the site. Then anchor-line attachments, blocks, equipment, and other miscellaneous material were placed aboard and the caissons were towed to position and made fast to the previously installed anchor blocks and lines. Sinking was accomplished in the usual way by constructing additional lifts of structural steel, reinforcing steel, and concrete. No attempt was made to hold the caisson accurately to position during the floating stages, it being allowed to drift back and forth with the ebbing and flowing tide as much as 20 ft. The main anchor lines having been socketed about 50 ft from the caisson and attached by an arrangement of 80 individual $^7/_8$-in. lines, it was necessary to continually adjust these lines while under stress to insure an even distribution of load. This became one of the major operations, as adjustments had to be made at every turn of the tide. Landing on the compact sand and gravel of the bottom was accomplished at the approach of a low slack tide. At slack tide anchorage requirements were at a minimum and the caisson was maneuvered into place by eight selected lines placed over electrically driven winches each controlled from a central control panel. The caisson could thus be maneuvered readily in ac-

Dumping a 600-Ton Anchor Block



I-Bars in the Cable Anchorages; Note the Welded Side Plates at the Pin Points

cordance with the directions from the triangulation party, and was landed just as the tide reached its lowest point by pumping in water ballast. Sinking through 55 ft of material for Pier 4, and 100 ft of material for Pier 5, was accomplished by removing the bottom doors and excavating through the wells in the usual manner.

The specifications provided that the 25-ft concrete block on the bottom of the pier should be placed with bottom-dump buckets. The contractors, however, requested permission to place this concrete through tremie pipes 12 in. in diameter, and this was successfully accomplished with a maximum length of tremie, in Pier 5, of 240 ft. Concrete in the caisson was proportioned for 1.55 bbl of cement per cubic yard with a maximum aggregate of $1^1/_2$ in. To increase resistance to sea water, modified portland cement was used, as described for the anchorages. Strengths in standard 28-day compression cylinders averaged 5,150 lb per sq in.

Topping Out the Tower on the West Main Pier

The main cable anchorages consist of 20,000-cu yd concrete blocks placed on the sand and gravel formation about 80 ft above the clay stratum and a sufficient distance back from the banks to insure against sliding. Their stability was computed on the basis of a coefficient of sliding friction of 0.4 and a maximum bearing load of 6,000 lb per sq ft. No allowances were made for the passive resistance of material in front of the block or the resistance developed along the sides. These large blocks of mass concrete were cast in rectangular units of from 600 to 800 cu yd each, so arranged that no adjacent unit was poured until each block had had at least 5 days' curing time. The cement used for this work as well as for the piers was a sulfate-resistant, low-heat cement designated by the Federal Specification Board as SS-C-206. Cement content per cubic yard was 1.15 bbl. Aggregates up to a maximum size of 3 in., and segregated into two classes—one from $^1/_4$ in. to $1^1/_2$ in., and the other from $1^1/_2$ to 3 in.—were used. Concrete strengths as shown on standard 28-day compression cylinders averaged 4,190 lb per sq in. For the usual I-bar attachments to the main cables, I-bars fabricated of heavy plates were used. At the pin points these plates were reinforced with side plates welded thereon. Before final approval was given to this detail, as developed by the Bethlehem Steel Company, tests were made at the Fritz Engineering Laboratories of Lehigh University to check stress distribution and design methods. These tests were reported in the August 1939 issue of *The Welding Journal.*

The design and construction of the superstructure, while following along well-established lines, includes a number of interesting developments. Among these are the large span-to-width ratio of 72 as contrasted to the ratio of 45 for the Golden Gate Bridge, the use of stiffening girders, all-welded main saddle and cable band, and the simplified arrangement of the strand shoes.

The two main towers are 420 ft in height and are made up of stiffened plates and angles all arranged in a cruciform section (Fig. 5), with bracing provided by four deep horizontal struts. The tower is designed to be bent shoreward a maximum of 3 ft during erection, with final dead-load positions 3 in. shoreward. The stiffening system consists of two 8-ft girders, 39 ft on centers, together with the floor system of stringers, laterals, and $5^1/_4$-in. concrete slab, which are placed at about the neutral axis of the girders. The main-span cables are very stiff, having a sag ratio of 1 to 12. The design of the girders is controlled principally by lateral forces, the $^1/_2$-in. plates of the main girders being stiffened to insure participation of the entire girder section in compression. In the design of the system for resistance to these lateral forces, partial advantage was taken of the stiffness of the concrete floor and the composite action of the entire floor system. Lateral loads were taken at 30 lb per sq ft on $1^1/_2$ times the projected area and on the live load.

It is computed that the maximum wind forces will result in a lateral movement in the main span of 20 ft. Because of the extreme lateral flexibility of the structure, an attempt is being made to study its dynamic behavior by the construction of a model at the University of Washington. The model represents the entire bridge width with the floor system in place and is scaled for

All-Welded Main Cable Saddles—an Important Innovation on the Tacoma Narrows Bridge

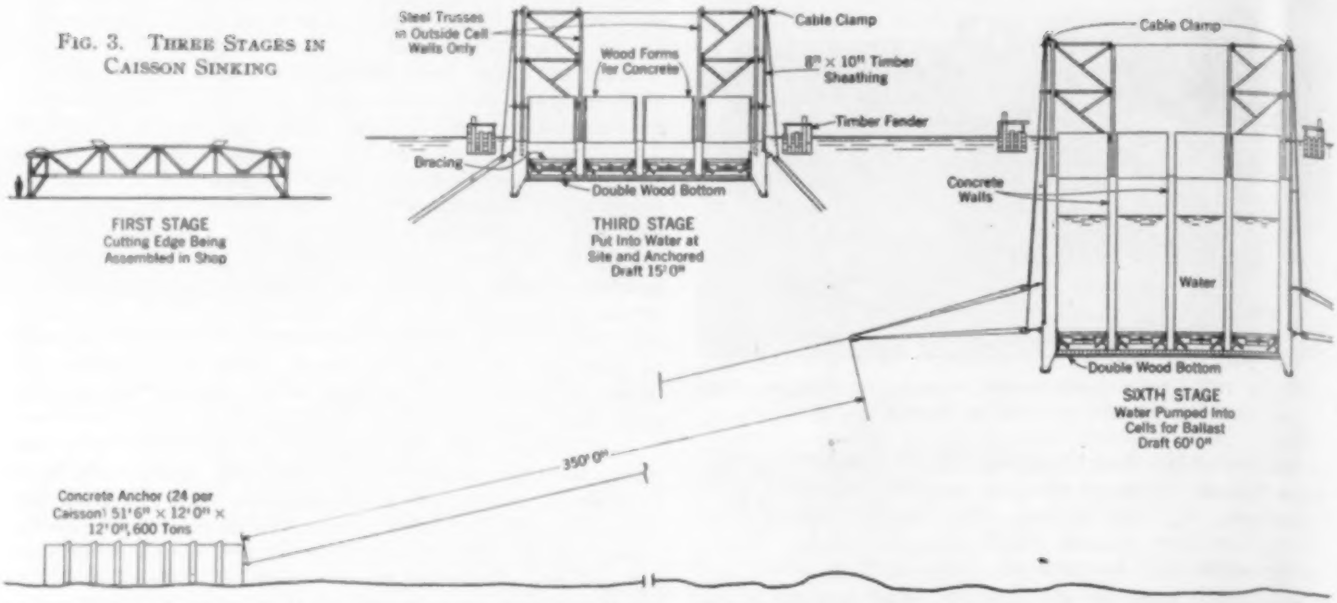


FIG. 3. THREE STAGES IN CAISSON SINKING

all principal characteristics—the lineal dimensions, elastic behavior, weight, and so forth. It is expected that these model studies will be completed before the completion of the superstructure and that advantage can therefore be taken of them in the final arrangement of the central span in the damping out of any set wave pattern.

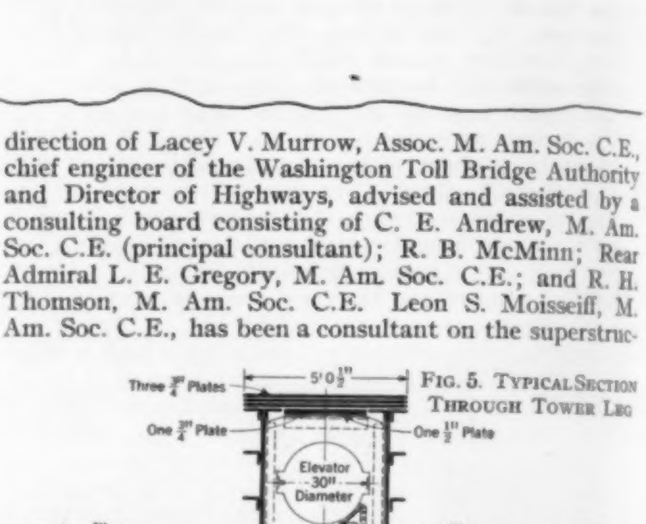
The main cable saddles at the tops of the main towers are all-welded units, a detailed study having indicated that with the welded design better stress distribution could be accomplished more economically, and all the uncertainties inherent in cast-steel units could be eliminated. The design of these weldments was worked out in the Toll Bridge Authority design office in close collaboration with the engineering department of the Bethlehem Steel Company. Because of the large size and exact dimensions required in the cable trough, close conformity to manufacturing technique was required. Cable bands, likewise, are all of welded construction, which has also resulted in a material reduction in weight and improvement in quality.

The strand shoes at the anchorage I-bars are placed one on each side of the steel plate bar, thereby eliminating many of the erection difficulties that have been encountered with the usual detail.

Work on the project was undertaken November 23, 1938, and it is expected that it will be completed June 30, 1940. The general contract is held by a combination consisting of the Pacific Bridge Company of San Francisco, the General Construction Company of Seattle, and the Columbia Construction Company of Bonneville, the Pacific Bridge Company being the operating company. This group of companies constructed the piers and anchorages, completing this work in September 1939. The superstructure work is held under subcontract by the Bethlehem Steel Company, the bridge wire being produced by the John A. Roebling Sons Company.

The project was designed and is being constructed under the general direction of Lacey V. Murrow, Assoc. M. Am. Soc. C.E., chief engineer of the Washington Toll Bridge Authority and Director of Highways, advised and assisted by a consulting board consisting of C. E. Andrew, M. Am. Soc. C.E. (principal consultant); R. B. McMinn; Rear Admiral L. E. Gregory, M. Am. Soc. C.E.; and R. H. Thomson, M. Am. Soc. C.E. Leon S. Moisseiff, M. Am. Soc. C.E., has been a consultant on the superstructure design, and in the preliminary stages of the work the firm of Moran, Proctor, and Freeman was consulted on the substructure design. The writer is bridge engineer for the Toll Bridge Authority, in direct charge of design and construction. David L. Glenn is chief resident engineer for the PWA, and the RFC has been represented by T. L. Condron, M. Am. Soc. C.E., with James H. Roper, Assoc. M. Am. Soc. C.E., as resident engineer inspector during later stages.

FIG. 5. TYPICAL SECTION THROUGH TOWER LEG



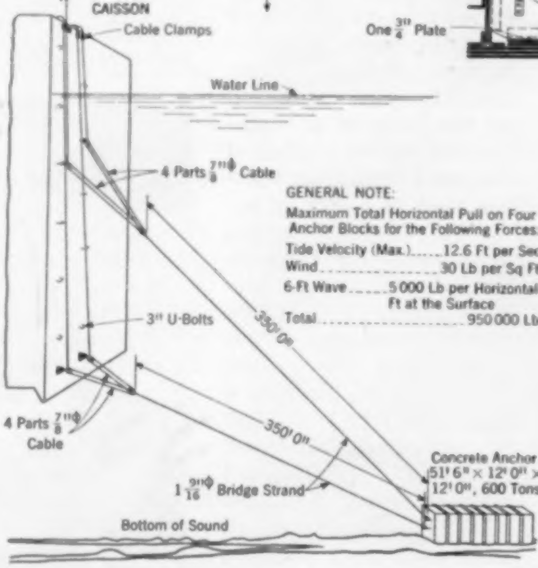


FIG. 4. SKETCH OF CAISSON—ANCHOR CONNECTIONS

Studies of Rainfall Intensity

Second of Two Groups of Papers on Hydrologic Investigations at Washington University

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Introduction

By W. W. Horner

THE two investigations reported here by Messrs. Breihan and Armistead deal entirely with occurrence of rainfall at or exceeding specific intensities.

Breihan's study involved an analysis of mean hourly rainfall, and is important for the reason that hourly amounts are now becoming available out of the new procedure of the Weather Bureau, and there is a definite tendency in engineering practice to use these values as though they were actually uniform rates throughout the hour. To the extent that these hourly mean rates are used in the analysis of particular storms in connection with available knowledge of stream flow, the resulting infiltration capacities do not have direct physical value, and merely represent the infiltration capacity that would have had to exist to produce the actual known excess rainfall, if the precipitation had been of uniform intensity throughout the hour. On the other hand, if a mean hourly rate may be reexpressed as a series of rates, as the precipitation probably really occurred, the resulting infiltration capacity values will be much more nearly the true values that existed.

The results of Breihan's study will be most illuminating to the hydraulic engineer. The fact that for a rainfall having a mean hourly value between $1/2$ and 1 in. per hour, 80% of the precipitation on the average occurs in excess of the hourly rate, presents an entirely new picture; and when it is shown that 45% of the precipitation probably occurs at rates twice the mean hourly rate, it is necessary to give very serious consideration to the results this fact will have on hydrologic applications.

As an extreme example, let us suppose that the average infiltration capacity for a certain area is 1 in. per hour. If an hour's rain occurred at a uniform rate of 1 in. per hour, there would be no excess rainfall; but if, as in the most probable case, 80% of the precipitation occurred at rates in excess of 1 in. per hour, the true excess rainfall would be a material amount. The writer believes that to produce valid results, either in the determination of infiltration capacity from precipitation and stream-flow records, or in the application of infiltration capacity to design storms in order to estimate flood flows, the relationships presented in Breihan's paper must be taken into account.

The second paper, by Armistead, breaks down annual rainfall into its probable intensity occurrence. The resulting graph (Fig. 2) gives the amount of rainfall likely to occur in excess of any specific intensity in any one of three parts of the annual cycle. If general values of infiltration capacity are available for a particular area, it is possible, from graphs such as this, to determine the probable surface runoff from that basin for each of the three parts of the year whenever a good series of precipitation values by months is available. Such information will permit of a much more definite estimate of that part of watershed yield coming from surface runoff than has been possible through any of the relationships heretofore applied.

Considering that this investigation involved the use of only one year's record, the curves shown in Fig. 3 indicate a rather definite pattern. If the same application were made to a record of five or ten years, it seems probable that these curves would be quite smooth for each of the intensity rates selected.

Acknowledgment is made to the Soil Conservation Service for the use of its basic data.

Relation of Hourly Mean Rainfall to Actual Intensities

By Erwin R. Breihan

THIS study involved an investigation of rains having an average intensity of $1/2$ in. or more per hour, with a view to determining at what intensities the precipitation occurred during each hour investigated. Although heavy rains are usually reported as so many inches per hour, and the reported values are often used as mean uniform intensities for the whole hour, this never presents a true picture of how the rain actually fell. Nature never allows a rain to fall at one rate for a whole hour; therefore the rain must fall at different intensity rates than the mean intensity rate. The objective of this study was to determine, for any hour having a mean recorded intensity, the probable rates at which the rainfall actually occurred.

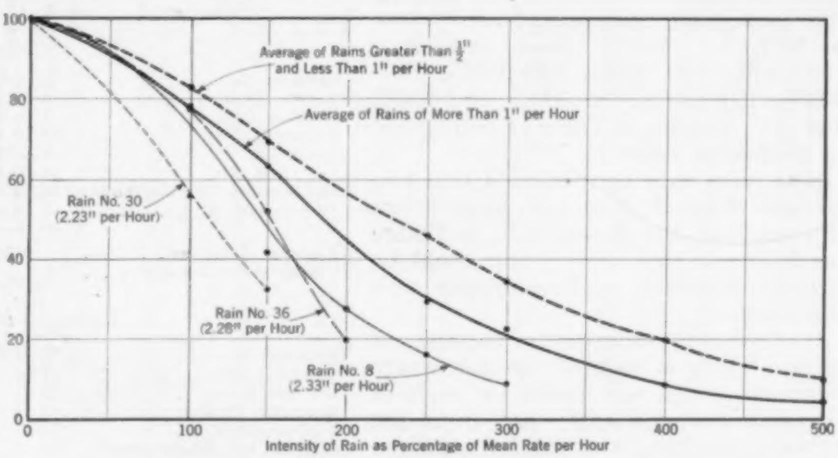

Fig. 1. Cumulative Percentages of Rainfall Amounts vs. Intensity of Rainfall in Percentage of Hourly Mean Intensity

TABLE I. FIRST STEP IN ANALYSIS OF TYPICAL RAINFALL

No.	Time	Date	Amount	Inches of Rain Falling in Intensity Groups: 0.1 to 0.2	0.2 to 0.3	0.3 to 0.4	0.4 to 0.5	0.5 to 0.6	0.6 to 0.7	0.7 to 0.8	0.8 to 0.9	0.9 to 1.0	1.0 to 1.25	1.25 to 1.50	1.50 to 1.75	1.75 to 2.0	2.0 to 2.5	2.5 to 3.0	3.0 to 3.5	3.5 to 4.0	4.0 to 5.0	5.0 to 6.0	6.0 to 7.0	7.0 to 0.0
84	2–3 p. m.	7/21/38	1.42	...	...	...	0.03	...	...	0.05	...	0.03	....	....	0.05	0.13	...	0.09	...	0.25	0.23	0.25	0.31	...

The study was made from the records of several Weather Bureau stations, all but one of which are in the Mississippi Valley. They are located in a strip that runs through the central part of the United States, and, being rather well scattered, give a fairly representative sample for it. The study was not intended to be exhaustive, and only the records that were at hand were investigated. Much more time and many more records should be used to give this subject the consideration needed for a complete study.

Most of the data were obtained from photolith prints published by the Soil Conservation Service, which give directly, for each precipitation period, the amounts of rain that fell at the different intensity rates. Other data were obtained from the mass curves of the recording gages at the Washington University and the Edwardsville stations. The stations included in the study are tabulated below:

Station	Official Status	Period Studied
Bethany, Mo.	Soil Conservation Service	2 yr, 1933–34
Guthrie, Okla.	Soil Conservation Service	5 yr, 1932–37
Clarinda, Iowa	Soil Conservation Service	5 yr, 1934–39
Zanesville, Ohio	Soil Conservation Service	5 yr, 1934–39
Waco, Tex.	Soil Conservation Service	1 yr, 1938
La Crosse, Wis.	Soil Conservation Service	6 yr, 1933–39
Edwardsville, Ill.	Soil Conservation Service	2 yr, 1938–40
St. Louis, Mo. (Washington University)	Cooperative station	1 1/2 yr, 1938–40

The only rainfalls considered were those in which 1/2 in. or more fell within one clock hour. For each such rain the place, date, hour, total amount falling in the hour, and amount falling in each "intensity rating group" were recorded. The intensity groupings used were as follows: every tenth of an inch up to an intensity of 1 in. per hr, every quarter inch up to 2 in. per hr, every half inch up to 4 in. per hr, and then every inch up to 7 in. per hr. All rains having intensities of greater than 7 in. per hr were recorded in the 7-in. column. A sample recording is shown in Table I.

After recording all rains in this manner, the percentages of rainfall amounts falling at various intensities represented as percentages of the hourly mean intensities were computed. As shown in Table II, the percentage groupings used were 0–100% (of hourly mean intensity), 100–150%, 150–200%, 200–250%, 250–300%, 300–400%, 400–500%, and 500% and up. Entries in Table II correspond to the data in Table I.

The rains were then divided into two groups—those of 1/2 to 1 in. mean intensity per hour, and those of 1 in. and more per hour—so that each group could be studied separately and compared with the other.

The average percentage of the amount of rain falling in each of the percentage intensity groups was found for each of the stations considered, and from the average percentages of rainfall amounts the cumulative percentages were computed. Finally, the average and the cumulative percentages for each of the two groups of rains, considering the results of all the stations, were calculated. All these data are shown in Table III.

In Fig. 1 the cumulative percentages of each group of rains are plotted, to show the differences in the characteristics of the two groups. In addition, the individual cumulative percentage curves of three of the heaviest rains are also shown. Finally, the vertical line through the 100% division on the abscissa represents an imaginary "ideal" rain, having a uniform rate for the whole hour, this rate necessarily being the mean intensity per hour. The plottings show clearly

TABLE II. SECOND STEP IN ANALYSIS

No.	Time	Date	Amount	Percentages of Rainfall Amounts Falling at Intensities Represented as Percentages of the Hourly Mean Intensity: 0 to 100	100 to 150	150 to 200	200 to 250	250 to 300	300 to 400	400 to 500	500 and up
84	2–3 p. m.	7/21/38	1.42	7.8	12.7	6.3	17.6	16.2	17.6	21.8	...

that as the amount of rain falling per hour increases, more of the rain falls at percentage rates that are near the 100% average intensity rate, and the curve more and more approaches the rain of uniform intensity.

How the graph of Fig. 1 can be utilized to analyze a given rain is shown in Table IV. The rain selected was listed as No. 112, and occurred from 9 to 10 a.m., October 30, 1935, at the La Crosse (Wis.) station. The results of the calculations and the actual observed values are both shown.

From the above results, it is apparent that knowing the average intensity of rain for an hour, it is possible to determine the probable intensities at which it actually

TABLE III. SUMMARY OF RAINFALL INTENSITY ANALYSES

Rains of 1/2 to 1 in. Mean Intensity per Hour

Station	No. of Rains	Average Amounts	Percentages of Total Rainfall per Hour Falling at Intensities Represented as Percentages of the Hourly Mean Intensity: 0 to 100	100 to 150	150 to 200	200 to 250	250 to 300	300 to 400	400 to 500	500 and up
Bethany, Mo.	10	0.64	17.8	12.1	15.4	10.8	14.5	6.3	12.1	11.5
Guthrie, Okla.	15	0.75	14.9	16.2	12.7	7.0	17.4	17.8	10.8	3.5
Clarinda, Iowa	1	0.60	26.7	..	..	46.7	..	..	..	26.6
Zanesville, Ohio	27	0.70	20.1	9.4	17.5	11.8	9.7	19.2	8.1	4.4
Waco, Tex.	3	0.72	14.2	11.9	4.0	6.7	14.0	22.1	26.1	..
La Crosse, Wis.	34	0.70	16.9	17.8	13.1	13.7	11.8	10.4	6.0	11.1
St. Louis, Mo. (Washington U.)	14	0.66	16.2	17.1	9.2	7.5	6.2	25.9	12.2	7.1
Edwardsville, Ill.	7	0.70	11.5	9.3	8.4	3.6	..	10.1	18.8	38.4
Averages of stations		0.695	17.1	14.1	13.2	10.7	10.8	15.3	9.8	9.6
Cumulative percentages		..	100.6	83.5	69.4	56.2	45.5	34.7	19.4	9.6

Rains of 1 in. or Greater Mean Intensity

Station	No. of Rains	Average Amounts	0 to 100	100 to 150	150 to 200	200 to 250	250 to 300	300 to 400	400 to 500	500 and up
Bethany, Mo.	5	1.54	27.5	17.2	17.8	6.5	14.1	6.2	..	2.4
Guthrie, Okla.	9	1.54	25.9	14.7	27.1	19.7	4.7	3.1	4.7	..
Clarinda, Iowa	2	1.13	28.2	9.8	..	..	14.3	8.9	..	38.7
Zanesville, Ohio	6	1.37	19.2	18.6	3.2	6.0	3.8	39.6	6.9	2.8
La Crosse, Wis.	6	1.39	19.6	21.2	27.8	9.6	7.0	7.2	4.7	2.8
St. Louis, Mo. (Washington U.)	2	1.10	7.5	..	..	50.0	..	42.5	..	..
Averages of stations		1.42	22.5	15.9	17.3	15.1	6.9	14.2	4.2	4.1
Cumulative percentages		..	100.2	77.7	61.8	44.5	29.4	22.5	8.3	4.1

fell, and the amount falling in excess of any particular intensity. If it were possible to make a long-time study

TABLE IV. CALCULATED AND ACTUAL VALUES OF RAIN NO. 112 (AMOUNT, 0.52 IN. PER HR)

INTENSITIES, in percentages of hourly mean	0 to 100	100 to 150	150 to 200	200 to 250	250 to 300	300 to 400	400 to 500	500 and up
INTENSITIES, in in. per hour .	0.00 0.52	0.52 0.78	0.78 1.04	1.04 1.30	1.30 1.56	1.56 2.08	2.08 2.60	2.60 ....
CALCULATED AMOUNTS, in in.:								
In each intensity group .	0.09	0.07	0.07	0.05	0.06	0.08	0.05	0.05
Cumulative	0.52	0.43	0.36	0.29	0.24	0.18	0.10	0.05
ACTUAL AMOUNTS, in in.:								
In each intensity group .	0.09	0.03	0.15	0.00	0.00	0.20	0.00	0.05
Cumulative	0.52	0.43	0.40	0.25	0.25	0.25	0.05	0.05

of the rains in some one district, analyzing them in the same manner, the probable intensities could be determined quite accurately.

Rainfall Intensity Study for 1938–1939, for Edwardsville, Ill.

By H. G. ARMISTEAD, JR.

THE object of this study was to find some method of breaking down rainfall intensity data into a simple, usable form, with respect to annual occurrence.

Because of limitations of time, it was possible to study the records of only one year, from March 1938 through February 1939. The tabulated rainfall records for Gage No. 2 of the Soil Conservation Service at Edwardsville, Ill., were used. (These were not quite complete; on three rains it was necessary to substitute the records from Gage No. 3, located close by.)

These data were analyzed as follows: A set of tabulations was prepared for each precipitation occurrence during the full year, showing the total amount occurring, the approximate duration, and the amount occurring in each of about twenty intensity groups varying from 0.1 to 7.0 in. per hr. These records were broken up to show the amount of precipitation within each of these intensity groups for each month. (See Table V.)

A small amount of precipitation falling at very low intensities for short periods of time, which could not be secured from the recording gage records, was added to the lowest intensity group in order that the total rainfall used in the calculations should equal the total rainfall for the year at that station.

For simplification, this material was combined into 12 intensity groups. To make the values more generally applicable, the actual amount of precipitation occurring

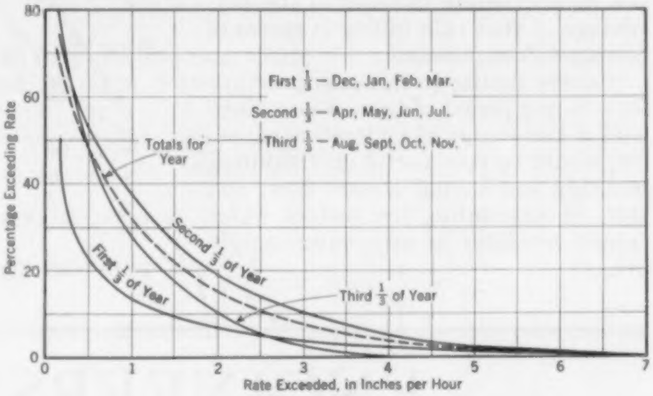

FIG. 2. PERCENTAGE OF RAINFALL EXCEEDING ANY GIVEN RATE OF PRECIPITATION, IN VARIOUS FOUR-MONTH PERIODS

Data from Gage No. 2, Edwardsville, Ill., Mar. 1938–Feb. 1939

in excess of each chosen intensity was divided by the monthly total, resulting in percentages of the monthly precipitation, occurring in excess of each of the precipitation rates. These values were combined for four-month periods, each representative of a distinctive part of the water year. The percentage falling in excess of each of these rates for each period was plotted on a graph showing the values for each third, and also the yearly values. (See Fig. 2.)

In addition, a graph was prepared with months shown across the bottom, and points plotted showing the per-

TABLE V. AMOUNTS OF PRECIPITATION OCCURRING AT VARIOUS INTENSITIES, EDWARDSVILLE, ILL.

INTENSITY IN. PER HOUR	1938										1939		TOTALS
	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	
0 –0.1	2.23	0.72	0.72	0.30	0.76	0.07	0.24	0.14	0.695	1.01	1.54	0.96	9.385
0.1 –0.2	0.98	0.83	0.50	0.44	0.33	0.18	0.10	0.16	0.55	0.38	1.37	0.68	6.50
0.2 –0.3	0.74	0.18	0.96	0.35	0.31	0.11	0.05	0.02	0.60	0.18	0.48	0.30	4.28
0.3 –0.4	1.04	0.26	0.56	0.21	0.23	0.08	0.10	0.07	0.735	0.11	0.47	0.20	4.065
0.4 –0.5	0.44	0.22	0.21	0.26	0.18	0.08	0.14	0.04	0.68	0.02	0.08	0.03	2.38
0.5 –0.6	0.05	0	0.09	0	0.06	0	0	0	0	0	0	0	0.20
0.6 –0.7	0.35	0.26	0.34	0.11	0.36	0.08	0.05	0.20	0	0.09	0.05	0.07	1.96
0.7 –0.8	0.35	0	0.29	0.12	0.13	0.06	0.05	0	0	0	0.06	0.23	1.29
0.8 –0.9	0.14	0	0.15	0.25	0.11	0.15	0.08	0	0	0	0	0.14	1.02
0.9 –1.0	0.08	0.06	0.14	0.03	0.16	0	0.18	0	0	0.03	0	0.03	0.71
1.0 –1.25	0.39	0.08	0.11	0.42	0.68	0.23	0.28	0.02	0.08	0.06	0	0	2.35
1.25–1.5	0.24	0	0	0.43	0.70	0.12	0.11	0	0	0	0	0	1.60
1.5 –1.75	0.32	0	0.36	0.05	0.71	0	0	0	0.02	0.10	0	0	1.56
1.75–2.0	0.54	0	0.21	0.12	0.85	0.15	0	0.03	0	0	0	0	1.90
2.0 –2.25	0.27	0	0	0	0.29	0.07	0	0.09	0	0	0	0.18	0.90
2.25–2.5	0.15	0	0.40	0.04	0	0	0	0.04	0	0	0	0	0.63
2.5 –2.75	0.44	0	0	0	0	0	0	0.09	0	0	0	0	0.53
2.75–3.0	0	0	0.[illegible]	0.37	0.24	0	0	0.14	0	0	0	0	0.98
3.0 –3.5	0.05	0	0.5[illegible]	0.27	0.15	0	0	0	0	0	0	0	1.03
3.5 –4.0	0.32	0	0.33	0.06	0	0.13	0	0	0	0	0	0	0.84
4.0 –5.0	0.55	0	0.07	0	0	0	0	0	0	0	0	0.14	0.76
5.0 –6.0	0	0	0	0.68	0	0	0	0	0	0	0	0	0.68
6.0 –7.0	0.11	0	0.10	0	0	0	0	0	0	0	0	0	0.21
Totals.....	9.78	2.61	6.33	4.51	6.2	1.51	1.38	1.04	3.36	1.98	4.05	2.96	45.76

Total rainfall ↑

centage in each month falling in excess of each of six selected intensity values. (See Fig. 3.)

The results of Fig. 3 are very interesting, seeming to follow the same pattern as Meyer's curves for amounts of precipitation occurring in any month (*Elements of Hydrology*, by A. F. Meyer, Wiley, New York, 1928, pages 114–118). It is interesting to note that, as the amount of precipitation occurring in any month increases, there is a proportionate increase in the percentage of that rain falling in excess of certain different rates.

A study similar to this, using records for a longer period of time, if combined with a knowledge of infiltration capacity, would be very useful in computing monthly and annual stream flow, and thus in calculating the surface water supply available at any water supply project.

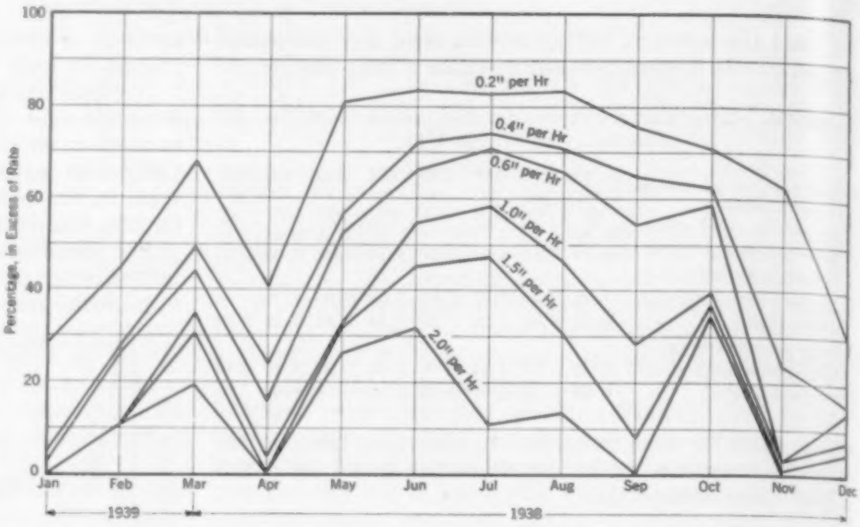

FIG. 3. PERCENTAGE OF MONTHLY PRECIPITATION FALLING IN EXCESS OF VARIOUS SELECTED RATES

Data from Gage No. 2, Edwardsville, Ill., March 1938 Through February 1939

ENGINEERS' NOTEBOOK

Ingenious Suggestions and Practical Data Useful in the Solution of a Variety of Engineering Problems

Formulas for the Solution of Catenary Problems

By JOSEPH JOFFE

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EQUATIONS of the common catenary involve transcendental functions and frequently have to be solved by approximate methods. In this article Newton's method for the solution of equations is used to derive formulas by means of which catenary problems may be solved accurately and systematically. In the discussion that follows, only the catenary with supports at the same level (Fig. 1) will be considered.

The problems may be separated into three types, in which: (1) the span, a, and the sag, b, are given; (2) the span, a, and the length of the cable, L, are given; (3) the span, a, and the tension, T, at the point of support are given. In all three cases, w, the weight or load per unit length of cable, is also given. The solution in each case consists in first finding c from the equations of the catenary, c being defined as H/w, where H is the minimum tension in the cable. A preliminary value of c must be obtained either by trial or by assuming the curve to be a parabola as a first approximation.

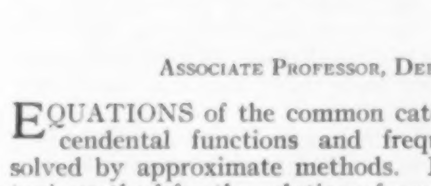

FIG. 1. THE CATENARY

Consider the case where the span and sag are given. From the equation of the parabola we have $c_1 = \dfrac{a^2}{8b}$.

Applying Newton's method, if $c = c_1$ is an approximate solution of the equation $f(c) = 0$, it follows that a more accurate solution is $c = c_2$, where

$$c_2 = c_1 - \frac{f(c_1)}{f'(c_1)} \qquad \ldots\ldots(1)$$

The equation of the catenary may be written as

$$\cosh \frac{a}{2c} - 1 - \frac{b}{c} = 0 \qquad \ldots\ldots(2)$$

Applying Eq. 1, we have

$$c_2 = c_1 + c_1 \frac{c_1 \cosh \dfrac{a}{2c_1} - c_1 - b}{\dfrac{a}{2} \sinh \dfrac{a}{2c_1} - b} \qquad \ldots\ldots(3)$$

Since c_3 may be obtained from c_2 by applying Eq. 1 a second time, we have in general:

$$c_{n+1} = c_n + c_n \frac{c_n\left(\cosh \dfrac{a}{2c_n} - 1\right) - b}{\dfrac{a}{2} \sinh \dfrac{a}{2c_n} - b} \qquad \ldots(4)$$

We solve the following illustrative problem with the aid of Eq. 4: $a = 500$ ft, $b = 80$ ft, $w = 6$ lb per ft;

to find the minimum and maximum tensions in the cable.

$$c_1 = \frac{500^2}{8 \times 80} = 391$$

$$c_2 = 391 + 391 \frac{391\left(\cosh \frac{500}{782} - 1\right) - 80}{250 \sinh \frac{500}{782} - 80} = 402.6$$

$$c_3 = 402.6 + 402.6 \frac{402.6\left(\cosh \frac{500}{805.2} - 1\right) - 80}{250 \sinh \frac{500}{805.2} - 80} = 403.4$$

$$c_4 = 403.4 + 403.4 \frac{403.4\left(\cosh \frac{500}{806.8} - 1\right) - 80}{250 \sinh \frac{500}{806.8} - 80}$$

i. e., $c_4 = 403.4 - 0.19 = 403.2$.

The value of $c = 403.2$ may be checked by substitution in Eq. 2:

$$\cosh \frac{500}{806.4} - 1 - \frac{80}{403.2} = 0$$

or, $1.1984 - 1 - 0.1984 = 0$.

It follows that the minimum tension $H = wc = 6 \times 403.2 = 2{,}419$ lb, and the maximum tension $T = w(b + c) = 6 \times 483.2 = 2{,}899$ lb.

To derive a formula for the case where the span and length of cable are given, we proceed as before, using the equation

$$\frac{L}{c} - 2 \sinh \frac{a}{2c} = 0 \qquad (5)$$

Applying Eq. 1,

$$c_{n+1} = c_n + c_n \frac{2c_n \sinh \frac{a}{2c_n} - L}{a \cosh \frac{a}{2c_n} - L} \qquad (6)$$

Finally, for the case where the maximum tension and span are given, we use the equation:

$$\frac{T}{wc} - \cosh \frac{a}{2c} = 0 \qquad (7)$$

Applying Eq. 1,

$$c_{n+1} = c_n + c_n \frac{c_n \cosh \frac{a}{2c_n} - \frac{T}{W}}{\frac{a}{2} \sinh \frac{a}{2c_n} - \frac{T}{W}} \qquad (8)$$

Two, or at the most three, applications of Eq. 4, 6, or 8 are usually found sufficient in the solution of the three types of problems on the catenary discussed above. In those cases where the ratio of sag to span is small, after a preliminary value of c is obtained on the assumption that the curve is a parabola, a single application of Eq. 4, 6, or 8 may be sufficient.

Artesian-Well Hydraulics by Unit-Head-Loss Method

By M. A. Churchill, Jun. Am. Soc. C.E.

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For solving problems in artesian-well hydraulics, the formula given by H. E. Babbitt and J. J. Doland, Members Am. Soc. C.E., in their work on *Water Supply Engineering* is usually employed:

$$Q = 2Kt \frac{(D - d)}{\log \frac{R}{r}}$$

where Q = rate of flow into the well
K = a constant for any particular well
t = thickness of the water-bearing formation
$D - d$ = drawdown in the well
R = radius of the circle of influence
r = radius of the well

The derivation of this formula is quite satisfactory from a purely mathematical viewpoint but it fails to convey a mental picture of the physical processes involved. This article has been prepared to present a new approach to artesian-well hydraulics which can be readily understood and applied.

In order for water to flow into a well from a water-bearing formation, the pressure must be less inside the well than outside. Drawing water from the well by a pump lowers the surface of the water in the well and so decreases the pressure on the water-bearing formation. This decreased pressure causes water to flow through the formation toward the well. However, in the process of flowing through the porous stratum, friction is developed between the moving water and the rock. The head loss so produced is the major reason why the water surface in the well is lower while the well is being pumped than when it is not. (See Fig. 1.)

For purposes of this discussion, it will be assumed that the aquifer, within the area affected by the well, is of uniform texture and of constant thickness. It must also be assumed that the water in the water-bearing formation

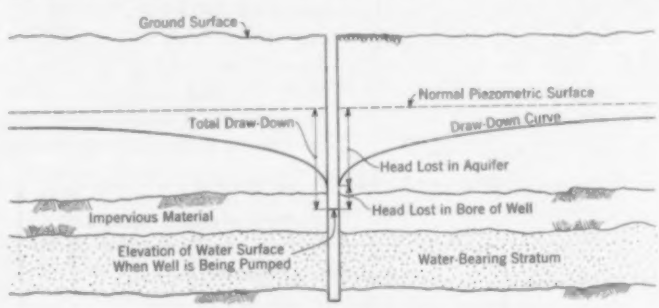

Fig. 1. An Artesian Well

is not moving before pumping of the well begins, and that the well completely penetrates the aquifer. If these conditions are not attainable, an error of some magnitude will be introduced into the calculations, whether the following method or any other method is used. If the varia-

tions from these conditions are known, however, the proper adjustments can be made.

Under the above conditions, water will flow toward the well equally from all directions when pumping is in progress, the velocity of the moving water varying inversely as the distance from the center of the well. For the purpose of this discussion, it will be assumed that the water has a velocity of 10 units as it enters the well. Under these conditions the velocity at a radial distance from the center of the well equal to 2 radii of the well will be 5 units; the velocity at a distance of 3 radii from the center will be 3.33 units; and so on.

Assume that the aquifer, about the well, is divided up into concentric vertical cylinders, each cylinder having a wall thickness equal to the radius of the well. The first, or inner cylinder, will have an inside diameter equal to the diameter of the well and an outside diameter equal to 2 diameters of the well; the second cylinder will have inside and outside diameters of 2 and 3 well-diameters, respectively; and so on.

If the velocities of the approaching water are plotted as ordinates, and the distances from the center of the well, in radii of the well, as abscissae, the true average velocity of the water as it passes through the walls of any cylinder can be determined by measuring the area under the corresponding portion of the velocity curve and then dividing this area by its width. The area can be measured with a planimeter, but it is easier and more accurate to compute it by calculus, since the equation of the velocity curve is simply $y = 10/x$, with y expressed in units of velocity and x in radii of the well. This curve is shown in Fig. 2. The area under the curve between $x = 1$ and $x = 2$ is 6.932 square units. The width of the area is 1, so the average velocity in the wall of the inner cylinder is 6.932 units of velocity. The average velocity in the wall of the second cylinder is 4.055 units, and so forth.

The head losses occurring in the walls of the imaginary cylinders are in direct proportion to the average velocities therein. Thus, assuming the head loss in the wall of the inner cylinder to be unity, the head loss in the wall of the second cylinder will be 0.585, and so on.

The total drawdown in the well must equal the sum of the losses occurring in the cylinder walls between the well and the outer limit of the circle of influence, assuming for the moment that the friction loss and velocity head inside the well bore are negligible. If the cumulative sums of the individual cylinder wall head-losses are plotted as ordinates, against distances from the center of the well (in terms of the radius of the well) as abscissae, the resulting curve will show relative head losses along the line of flow in the aquifer. The plotted relation of head loss in the aquifer to horizontal distance from the well constitutes what the writer is pleased to call a unit-head-loss curve.

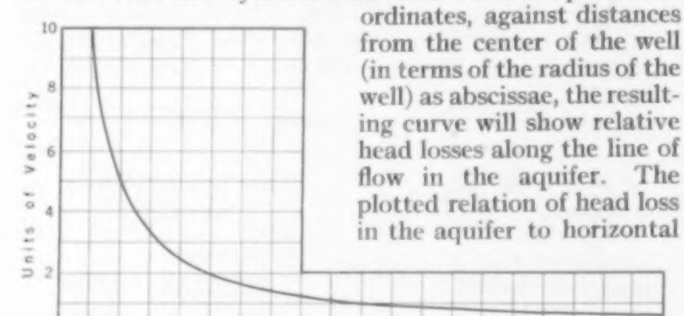

FIG. 2. RELATIVE VELOCITY CURVE

It would be laborious to compute the individual head losses in each of the cylinder walls in order to draw the unit-head-loss curve. However, if only the first few values are computed and plotted on semi-logarithmic paper, the equation of the curve may be found, as the graph is a straight line on this type of paper. The values of Y are values of head loss in terms of head loss in the inner cylinder wall. The values of x, plotted on the logarithmic scale, are expressed in terms of radii of the well. The equation of the curve is $Y = 3.322 \log_{10} x$. This curve is shown in Fig. 3, plotted on coordinate paper.

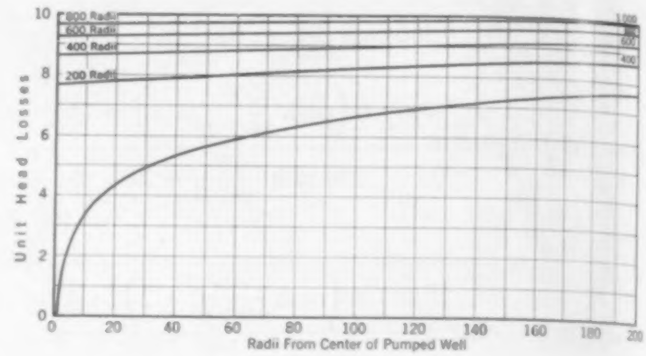

FIG. 3. UNIT-HEAD-LOSS CURVE

The curve shown has the general shape of every drawdown curve of every artesian well drawing its supply from porous non-fissured rock.

The relation of horizontal distance from the well to relative head loss in the aquifer is shown by the unit-head-loss curve. Practically any problem in artesian-well hydraulics can be solved by its use if we know the radius of the well where it penetrates the aquifer, the drawdown in the well at some particular pumping rate, and the drawdown at any other point within the circle of influence. If only the drawdown and rate of production are known, an approximate solution to many problems may be secured by assuming the radius of the circle of influence to be 1,000 radii of the well.

An example will best illustrate the use of the unit-head-loss curve. Suppose the drawdown in a well 12 in. in diameter, under some particular pumping rate, is 50 ft and the resulting drawdown in an observation well 100 ft away (point A) is 10 ft. How much drawdown will there be at a distance of 250 ft (point B) from the pumped well? What is the radius of the circle of influence? One hundred feet equals 200 radii in the case of a 12-in. well. Figure 3 is entered with the value 200 radii as an abscissa. The corresponding ordinate to the curve is 7.65. This value of ordinate shows that between point A and the well there is a head loss 7.65 times as great as that occurring in the wall of the inner imaginary cylinder. The actual value of the head loss between point A and the well is 50 minus 10, or 40 ft. The number of units of head loss is 7.65, and so the actual value of the unit head loss is 40 divided by 7.65, or 5.23 ft. This value of 5.23 ft is the actual head loss occurring in the wall of the inner cylinder, for this well, under the influence of the particular pumping rate. If the pumping rate changes, the head loss all along the drawdown curve will also change, and so the unit head loss will have a different actual value. The drawdown at a horizontal distance of 250 ft from the well can be found by entering the unit-head-loss curve with the value of 500 radii as an abscissa and noting the corresponding ordinate. This ordinate is found to be 8.96. This value indicates that between point B and the well, the head loss is 8.96 times 5.23 ft, or 46.86 ft. Therefore the drawdown at point B is 50 minus 46.86, or 3.14 ft.

The radius of the circle of influence, or the distance beyond which the well has no effect, can be found by dividing 50 by 5.23 and entering the unit-head-loss curve

with the quotient as an ordinate. The quotient is 9.56 and the corresponding abscissa is 756 radii, or 378 ft, which is the radius of the circle of influence.

Theoretically, of course, the radius of the circle of influence extends to the outer edges of the artesian aquifer (when the piezometric water surface before pumping begins is level), but there is a point beyond which the drawdown is so small that it may be neglected. This point marks the practical limit of the circle of influence.

In the above solution, it was assumed that the sum of the velocity head and the head loss due to friction resulting from the turbulent flow of water up through the bore of the well was negligible. Actually, part of the drawdown in every well is due to these losses. However, each well is an individual problem in this respect and no general solution can be given. In that part of the well which is cased with pipe, the friction loss can be fairly accurately evaluated by the use of the ordinary hydraulic formulas. However, in rock wells, that part of the well bore below the casing is not of uniform roughness, and so the engineer must use his own best judgment in choosing a roughness factor for it. The velocity head is usually small and can be neglected in practically all calculations.

Many other practical problems involving the relative discharge of a well under various drawdown conditions and the relative discharges of wells of different diameters, can readily be solved by use of tne unit-head-loss method.

The need for, and possible uses of, a simpler approach to well hydraulics became apparent to the writer while he was employed as Assistant Engineer in the Illinois State Water Survey. In the writing of this article he is indebted for encouragement and criticism to W. D. Gerber, J. J. Doland, and H. E. Babbitt, Members Am. Soc. C.E.; O. E. Meinzer, of the U.S. Geological Survey; A. S. Fry, M. Am. Soc. C.E.; and H. A. Schaill, Jun. Am. Soc. C.E.

Simplified Extraction of the Square Root

By Antonio Di Lorenzo, Jun. Am. Soc. C.E.

Draftsman, Gibbs and Cox, Inc., New York, N.Y.

The method discussed here of extracting the square root can be used to advantage when the number in question is not found in any handbook tables, or when a fairly accurate answer is required in a short time.

Computation of the square root, especially when several significant figures are required, is a somewhat tedious process. If a square root is obtained to any number of significant figures, the correct answer can be expanded to about three more significant figures by merely dividing half of the remainder in the operation at that point by the approximate answer.

The square root of 643 as given by handbooks is 25.3574447. If we take the approximate answer of 25.3, the remainder in the square root operation will be 2.91. Then $\frac{2.91}{2 \times 25.3} = 0.0575$ or $\sqrt{643} = 25.3575$.

Let the answer be the square root of the trinomial $(a^2 + 2ab + b^2)$ or $(a + b)$. Since the term a is the approximate answer, $2ab + b^2$ is the remainder. Obviously, b^2 is a very small quantity. Therefore,

$$2ab \doteq R$$

or

$$b \doteq \frac{R}{2a}$$

The final answer is then $\left(a + \frac{R}{2a}\right)$.

A similar method can be used successfully for cube roots by equating the second term of the polynomial $(a^3 + 3a^2b + 3ab^2 + b^3)$ to R.

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

New Graces for Growing Older

Much comment has been elicited by the article, "Compensation for Days of Retirement" from the pen of Robins Fleming, in the February issue. Its suggestions for worthwhile living even when the workaday world has given place to well-earned leisure, were more than pretty theory; they were based on solid experience, gained during the past nine years during which Dr. Fleming has been "retired." Comments were made mostly direct to the author; the responses, he says, "to the original article and the reprints have been surprising both in number and in their content." A few extracts from these personal letters are repeated here, with Dr. Fleming's permission.

"What you have to say about *The Elements of Euclid* arouses in me a keen desire to make the trial." *A high school teacher.*

"I am taking to heart your admonition that letters should usually be acknowledged soon after their receipt—wherefore this prompt acknowledgment." *An engineer of high position.* (Written the day of receipt of the reprint.)

"When I retire I think I will drop the pencil and slide rule and take up the garden trowel. Your suggestion to look at the stars intrigues me." *An engineer.*

"Fortunately I can feel that my job had become one that should be taken over by a younger man, not because I could not accept new ideas but because I feel that new ideas must be put into effect and that younger men are better fitted to meet changed conditions." *A "retired" engineer.*

"Your idea of substituting new things and new friends to make up a little for those that are gone seemed a fine and worthwhile thought. I hope I can remember to do that myself." *A busy housewife with a growing family.*

"I, too, have whiled away many a sleepless hour recalling bits of choice poetry, or even going through a quotation match all by myself in the very small hours of the morning until I fell asleep." *A high school teacher.*

"I know a couple of women who this very minute could profit greatly by grasping your statement that solemn thoughts need not be sad thoughts." *An engineer.*

"We felt that it was food for thought for both of us and might enable us to pick a hobby or an amusement from somewhere among the paragraphs which you wrote." *An engineer of high position.* (The "we" refers to an executive, also of high position.)

"I hereby quote from a passage, which I feel still carries out your thoughts. 'Youth is not a time of life—it is a state of mind. It is not a matter of ripe cheeks, red lips, and supple knees, it is a temper of the will, a quality of the imagination, a vigor of the emotions; it is a freshness of the deep springs of life. . . You are as young as your faith, as old as your doubt; as young as your self-confidence, as

old as your fear, as young as your hope, as old as your despair.'" *A contracting manager.*

"Your program for retirement is very suggestive and has made the anticipation of my retirement in a few years all the more attractive." *A widely known college professor.*

"I am facing the problem in less than two years. I'm looking forward to doing slowly and carefully, many things that I have always had to do hastily—my little flower garden for example. I want to do some simple cabinet work. . ." *A contract manager.*

"In my early days I found differential calculus a source of relaxation and a joy, not a task. I wish I could go back to it. If my 'days of retirement' ever come, I may be able to go back to it." *A non-technical author.*

"The administration in Washington and many of our educational institutions and industrial enterprises have adopted a policy based upon the theory that all people work with a single purpose of becoming retired. As a matter of fact, most of the people of my narrow and artificial acquaintance really desire to work as long as their health will permit. Nevertheless, they know that they will likely be retired against their will and are making mental and physical preparations for that day. Not for enforced idleness but for adopting a schedule of reading, study, travel, or writing to fill those years when the change has to be made." *A college professor.*

"When one has the time—when one has nothing but time—I agree with you that there are few things as fascinating as mathematics." *A "semi-retired" consulting engineer.*

"It is encouraging to those of us who are rapidly approaching that time to know that such adequate compensations do exist for those days of enforced idleness." *A college professor and writer.*

". . . and maybe establish pleasurable anticipations in the minds of so many of us who are approaching our own leisure time." *A contracting manager.*

"In my seventieth year and with retirement ahead I intend to profit by what you have written therein for I can see now where I can take a lesson out of your book and not become a bore to my friends in the days to come." *A college professor.*

"As you say, 'a person may be able to defer growing old indefinitely' and the present method of 'shelving' men (or women) at an arbitrary calendar age is a sad commentary on the mental processes employed by so-called intelligent men or companies or corporations. . ." *An engineer.*

The City Planner's Role in a Defense Program

TO THE EDITOR: Mr. Hartzog's paper on the "City Planner's Responsibility in the Preparedness Program," as presented in CIVIL ENGINEERING for March, serves a worthwhile purpose in emphasizing the need for the consideration of preparedness against war in city planning activities. I suggest, however, that another "general form of action" be added to the three listed by Mr. Hartzog. This suggestion might be entitled, "Furnishing of all practicable security against the crippling of vital facilities." In contradistinction to Mr. Hartzog's second suggestion, for the "industrial mobilization and utilization of economic resources"—which is fundamentally the offensive phase of defense—my suggestion would deal with pure defense, looking towards the reduction in amount of damage from an enemy attack.

From present-day experiences in Europe or from competent military officers, information could be secured regarding the objectives at which an artillery gunner or a bombing pilot aims. It seems reasonable to expect that, in a community under enemy attack, bombs would be dropped not only on industrial establishments but also on railroad and highway trunk lines, junction points, and bridges; on electric power stations; on telephone and telegraph central stations; and on water supply structures. Is it not possible that one well-placed bomb would shut off much, if not all, of the water supply of a city? With proper information, city planners might find that their plans could be modified to reduce the potential damage from shells or aerial bombs.

Considering the layout of trunk highways, which at present have their roadways either contiguous or separated by only a narrow strip, would it not be well to separate the two roadways by a strip 50 or 100 ft wide, so that at least two bombs would be required to put the highway out of commission? Instead of developing one major traffic artery between important industrial centers, perhaps we should have two—at some distance apart. We know that a bridge is a particularly vulnerable link, and the attacks on the Firth of Forth Bridge indicate that a bombing pilot recognizes this fact. However, there appears to be little chance of eliminating such vulnerability.

Several telephone exchanges should probably not be brought together in one building and, if at all feasible, electric power should be produced in several small stations rather than in one large one. Certainly a city's water should be supplied through several small mains instead of one large one. In some of our cities the central fire alarm station is well away from the business district but, if not, such removal from the probable "center of the target" should be considered.

It is undoubtedly true that, in many cases, decreased vulnerability could be obtained only at increased cost or at the sacrifice of other advantages. However, the writer wishes primarily to make the point that planners may well get suggestions from the air force and other military authorities regarding the vulnerability of traffic or other facilities essential to the life of a community and regarding the possible reduction of such vulnerability, and that they should take this factor into account in planning.

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Consulting Engineer

Boston, Mass.

Equations for Non-Homogeneous Sections Corrected

TO THE EDITOR: I wish to call your attention to errors which occurred in my article, "Analyzing Non-Homogeneous Sections Subjected to Bending and Direct Stress," in the March issue.

In Equations 2 and 3, the parentheses were placed wrongly. These equations should read:

$$f = \frac{P}{A} + \left(\frac{C_n}{C_d}\right) x_o + \left(\frac{D_n}{D_d}\right) y_o \qquad (2)$$

$$\frac{P}{A} + \left(\frac{C_n}{C_d}\right) x_o + \left(\frac{D_n}{D_d}\right) y_o = 0 \qquad (3)$$

Also, the equations to correct the properties to the centroid, at the top of the right-hand column on page 171, should be corrected to read:

$I_{x_0} = I_x - \Sigma a x_c^2;\ I_{y_0} = I_y - \Sigma a y_c^2;\ I_{x_0 y_0} = I_{xy} - \Sigma a x_c y_c;\ M_{x_0} = M_x - P x_c;\ M_{y_0} = M_y - P y_c.$

WILLIAM G. S. SAVILLE, Assoc. M. Am. Soc. C.E.
Associate Engineer, Bridge Design Section, TVA

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Test in Conformity with Shop Practice Urged

DEAR SIR: The information deduced from Professor Van den Broek's interesting experiments (see his article, in the February issue, entitled "Effect of Connections and Rivet Holes on Ductility and Strength of Steel Angles") may not prove to be of general practical value because in shop practice where small angles $^1/_8$ in. thick are used, transmissions through connections are through small rivets or bolts, not those of $^5/_8$-in. diameter used in his tests. For material $^1/_8$ in. thick, by using rivets $^1/_4$ to $^5/_{16}$ in. in diameter with holes oversize only $^1/_{64}$ in., the driven rivet deforms into and fills the hole. The hole spacing can be properly proportioned for the small rivets and more uniform stress distribution obtained than with $^5/_8$-in holes oversized $/_{16}$ in., drilled or punched in $^1/_8$-in. metal.

The engineer-draftsman designing for shop work in metals would like to see similar tests made with punchings and fastenings more in conformity with actual work as done.

The loose $^5/_8$-in. bolt in $^{11}/_{16}$-in. hole in $^1/_8$-in. metal gives uneven loading, eccentricity in bending, and minimization of distributive

stresses. Experiments with small rivet fastenings proportioned to the known resistance values of angles would give results which could be used in actual design of work. The same may be said of heavy angles with proportionately heavier rivets or bolts.

JACOB MARK, M. Am. Soc. C.E.

Brooklyn, N.Y.

Bridge Pier Movements Viewed as Consistent with "Blanket" Theory

TO THE EDITOR: In the closing paragraph of his article on "Settlement Studies of Huey P. Long Bridge," in the March issue, W. P. Kimball expresses the opinion that the clay blanket theory of the cause of the periodic rise and fall of the river piers is incompatible with the theory that there is no difference between the transmission of hydrostatic stresses in the water contained in clays and in that contained in sands. To support his theory he mentions the periodic up-and-down movement of the Holland Tunnel, which occurs in spite of the fact that there is no clay blanket between the river bottom and the tunnel.

The present writer claims that the alleged contradiction does not exist. Figure 1, illustrating his arguments, represents a simplified section through the Mississippi River which is confined between dikes. S_1 is an observation well whose walls are sealed against the clay. The water level in the well indicates the hydrostatic head in the sand located below the clay. The observation wells S_2 and S_3 are established above the clay. In the well S_3 the water always stands at or below the level of the surface of the ground because this well is located beyond the dikes. In the well S_2 the water level is practically identical with the level in the river which may rise to an elevation of many feet above the level in the well S_3. If the rise of the water in the river channel is not associated with a corresponding rise of the water level in the well S_1, the body of water located between water levels in S_2 and S_1 acts like a surcharge. It produces a settlement, and a subsequent fall of the river produces an elastic recovery. This condition is satisfied if the bottom of the river is separated from the lower sand by one or more continuous strata whose permeability is sufficiently small compared to that of the sand to maintain a notable difference between the water level in S_1 and that in S_2. It is irrelevant whether the layers consist of rubber which permits no transmission of hydrostatic stresses or of a very fine-grained soil through which there is free transmission of

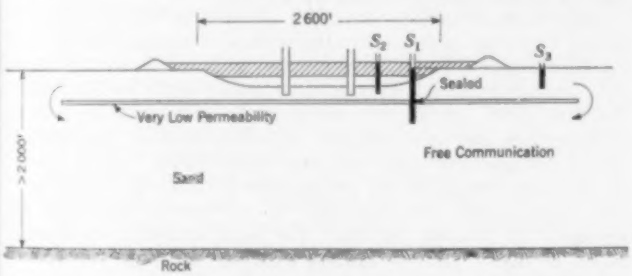


FIG. 1. SKETCH OF SOIL CONDITIONS UNDER MISSISSIPPI RIVER ON LINE OF BRIDGE

hydrostatic stresses. The only physical property that counts is the relative permeability of the layer or layers located between the bottom of the river and the lower sand.

However, a rise of the river would also cause a settlement of the piers under very different conditions. If the delta of the Mississippi consisted of solid rubber, a settlement would occur owing to the elastic deformation of the rubber due to a local increase of the surcharge. Furthermore, if the delta consisted entirely of soft silt with gaseous inclusions, the same phenomenon would occur, because beneath the river channel a rise of the river would cause a compression of the gas bubbles. In my opinion, the sinking of the Holland Tunnel associated with a rise of the Hudson River is due to gaseous constituents in the silt, because the silts in estuaries are very rarely free of such constituents.

KARL TERZAGHI, M. Am. Soc. C.E.

Cambridge, Mass.

Areas from Cross-Section Notes

TO THE EDITOR: In the March issue, Mr. Potts brings out the advantages of the coordinate method of calculating areas applied to cross sectioning. This method of calculating areas can be applied to any figure regardless of shape, as long as coordinates of the points of change of boundary are known.

Provided that the coordinates are placed in sequence, either clockwise or counter-clockwise, and ending at the same point of origin, more mechanical procedure may be applied to the computations as follows: Taking the area left of the center line in Mr. Potts's Fig. 1, the coordinates may be written as beginning at the point 0.0 and continuing clockwise around to the same point, all as shown in Fig. 1*a*. This method of writing the vertical distance over the horizontal is similar to cross-section notes. The procedure to calculate is as follows:

Multiply the numerator for each point by the difference of the adjacent denominators, using the denominator to the right as posi-

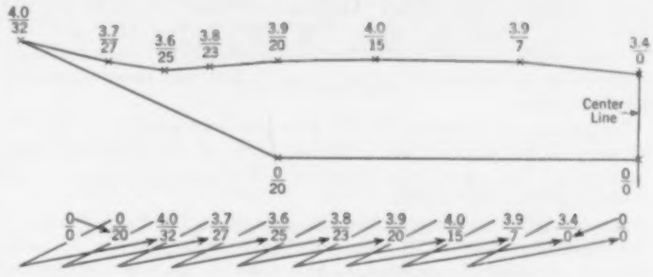


FIG. 1*a*

tive and the other as negative or vice versa and taking into account any signs. The arrows in Fig. 1*a* show these combinations and will prevent errors in using the wrong denominators. The resulting summation equals twice the area.

It is best to work each area to the right and left of the coordinates separately as it is apparent that this will eliminate using signs. Also the fill area will be calculated separately as it is necessary to know this area separately. The original cross-section notes can be used.

Note that coordinates of the shoulder and origin are added to the original notes. There is no need to add the 0/0 coordinates except to show that one must begin and end at the same point. All that is needed for most cross sections is the shoulder point.

Then, working from right to left:

$$\begin{aligned} 2A &= 3.4\,(7 - 0) + 3.9\,(15 - 0) + 4.0\,(20 - 7) + 3.9\,(23 - \\ &\quad 15) + 3.8\,(25 - 20) + 3.6\,(27 - 23) + 3.7\,(32 - 25) \\ &\quad + 4.0\,(20 - 27) \\ &= 196.8 \end{aligned}$$

For the right cut by same procedure: $2A = 44.0$.

Area in cut $= (196.8 + 44)^1/_2 = 120.4$ sq ft checking Mr. Potts's method.

This method automatically takes care of overbreak by simply adding the extra coordinates shown in Mr. Potts's Fig. 5; or it could be applied to the difference in area similarly, thus:

From Fig. 5, coordinates are

$$\frac{6.5}{32} \quad \frac{4.8}{28} \quad \frac{2.3}{24} \quad \frac{0.0}{20} \quad \frac{6.0}{30} \quad \frac{6.5}{32}$$

Computing,

$$\begin{aligned} 2A &= 6.5\,(28) + 4.8\,(24 - 32) + 2.3\,(20 - 28) + 0 + 6\,(32 - \\ &\quad 20) + 6.5\,(-30) \\ &= 2.2 \\ A &= 1.1\text{, directly in one step} \end{aligned}$$

This procedure, essentially the same as suggested by Mr. Potts, is made automatic by the steps suggested here. As will be found, it simplifies the calculations considerably and by machine calculation the total areas may be combined automatically.

R. LEE FRASER, Jun. Am. Soc. C.E.

Tulsa, Okla.

SOCIETY AFFAIRS

Official and Semi-Official

Spring Meeting Held in Kansas City

Lively Program of Engineering and Social Events Provided for Gathering in the Mid-West

IN THE COURSE of rotating the location of Society meetings throughout the country in order to serve the convenience of all members as far as possible, Kansas City was chosen for the 1940 Spring Meeting. Its many advantages made this a fortunate choice. Since the previous Society meeting in that city in 1926, a number of developments of engineering importance had taken place. The time was ripe for a gathering that would bring together engineers throughout the Missouri Valley and from an even wider area. Plans for the meeting took all these elements into account, with the result that there was a splendid attendance, keen interest in the technical features, and a full and most enjoyable social program.

Registration totaled about 800 members and guests, so that the evening social events taxed the capacity of the hotel's largest ballroom. The same full attendance characterized many of the Technical Division sessions.

As usual, various committees and conferences met in advance of the meeting proper. All sessions were held at the Hotel Continental. Regular formalities and courtesies opened the Spring Meeting officially on Wednesday morning, April 17. The remainder of the morning and all of the afternoon were devoted to a symposium covering the resources of the mid-continent area, varying from agriculture and industry to interests more closely allied to engineering, such as railroads, industries, and water resources. These sessions set the tempo for the technical features, giving a broad perspective on the problems of the whole area, to which more detailed attention was paid at the technical sessions on Thursday and Friday mornings.

An unusually full program had been prepared, to accommodate eight Division sessions plus one joint session of two Divisions. Thus ten out of the Society's twelve Technical Divisions were able to present valuable data in their special fields. The technical program as a whole was well rounded and was calculated to meet the needs and satisfy the interests of every member in attendance.

On Thursday, April 18, only the morning was devoted to technical sessions, as the afternoon had been reserved for trips. Beginning at nine o'clock, four Divisions held sessions—Structural, Highway, Power, and Sanitary Engineering. The session of the first-named was devoted to some reminiscences on bridge building, the question of gasoline pipe lines, and a description of Kansas City's fine Municipal Auditorium. Meanwhile the Highway Division was considering topics dealing with highway problems in Missouri, Colorado, and Kansas, as well as the popular subject of soil studies. In the Power Division meeting two general subjects were discussed, both relating to the generation of power—first, that from coal, and, second, that from oil and gas. Both proved to be stimulating and interesting. The fourth Division, Sanitary Engineering, also had a full program, devoted to problems of water supply in Wichita, Kans., of sanitation in Chicago, and of general problems in the mid-continent area.

The Friday program was similar to that for Thursday in that the morning was devoted to technical sessions and the afternoon to trips. The City Planning and Engineering Economics Divisions met in joint session, given over to papers on the economics of planning and on the cost of public services in new, as compared with old, residential areas. In an adjoining room the Hydraulics Division considered two topics in its field—turbulence and the determination of runoff from rainfall. The time allowed for discussion was well utilized. A third Division, on Surveying and Mapping, likewise scheduled two provocative subjects—reconnaissance surveys, and the general mapping program for the country.

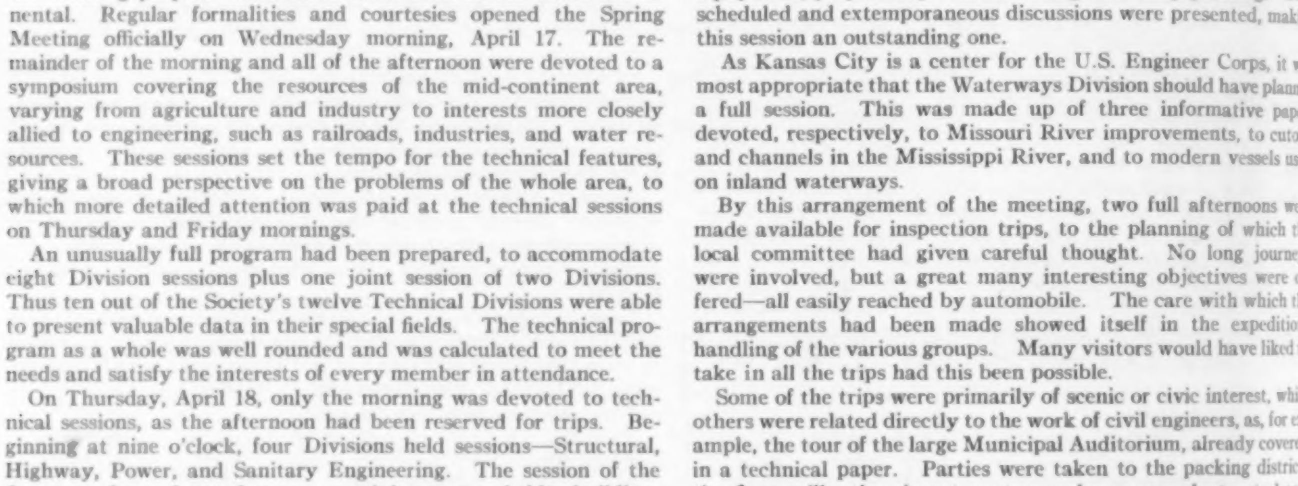
The ambitious program of the Structural Division comprised a group of six papers, all on the general subject of preparing and reconditioning steel for painting. Various phases of this subject were treated by experts—sand-blast cleaning, flame cleaning, equipment, preparatory reconditioning, and shop painting. Both scheduled and extemporaneous discussions were presented, making this session an outstanding one.

As Kansas City is a center for the U.S. Engineer Corps, it was most appropriate that the Waterways Division should have planned a full session. This was made up of three informative papers devoted, respectively, to Missouri River improvements, to cutoffs and channels in the Mississippi River, and to modern vessels used on inland waterways.

By this arrangement of the meeting, two full afternoons were made available for inspection trips, to the planning of which the local committee had given careful thought. No long journeys were involved, but a great many interesting objectives were offered—all easily reached by automobile. The care with which the arrangements had been made showed itself in the expeditious handling of the various groups. Many visitors would have liked to take in all the trips had this been possible.

Some of the trips were primarily of scenic or civic interest, while others were related directly to the work of civil engineers, as, for example, the tour of the large Municipal Auditorium, already covered in a technical paper. Parties were taken to the packing district, the flour mills, the airport, water works, power plants, steel and cement mills, and an oil refinery, as well as to other points of interest in this great shipping and industrial center. One entire trip was arranged primarily for the purpose of showing visitors the city and its residential development. In addition informal trips were arranged for smaller parties. The local members outdid themselves in taking care of visiting engineers and their families, beginning even as early as the Sunday before the meeting.

Of course social events were also on the program, the most outstanding being the formal dinner and entertainment on Wednesday



LARGE GROUP OF MEMBERS, STUDENTS, AND GUESTS ENJOY DINNER ON WEDNESDAY EVENING, APRIL 17, AT KANSAS CITY

evening. After an ample repast, the post-prandial features began with the introduction of Society and Section officers; then some fine music—vocal, instrumental, and community. As the crowning feature, U. S. Judge M. E. Otis gave a brilliant and scholarly address on "The Higher Law," in support of the common rights of man in a democracy. Almost 300 attended this event, including about 30 at the head table. Immediately afterward, in another ballroom, there was dancing, which was enjoyed especially by a large group of students for whom a number of attractive partners had been invited from the nearby University of Kansas City.

The Thursday evening dinner was less formal, but even better attended. Again there was a fine repast; again, good music. But the remainder of the evening was devoted to lighter entertainment, consisting of a program presented by a humorist, of acrobatic and tap dancing, and of a marionette performance. The high point was reached when four distinguished visiting engineers—all Society or Division officers—were presented to the gathering. To test their qualifications for "design," the local committee produced four feminine models together with lengths of draping cloth, horse-blanket pins, and other accessories. From the standpoint of the audience the resulting "designs" were most entertaining, especially one that was immediately named the "Niagara Falls motif." Generous prizes were then awarded by acclaim, in the form of medals of leather, tin, and similar valuable materials. Before the entertainment closed, opportunity was provided to voice appreciation of the local people who had given so generously of their time and energy in planning the Spring Meeting. In turn, the officers of the Section, the chairmen of the various meeting committees, and the chairwomen of all the ladies committees, were applauded enthusiastically, as their splendid work on all phases of the meeting merited.

Mention must be made of two regular features of Society meetings which were included in the program at Kansas City. The Local Sections Conference, representing Sections in the area, met all day Tuesday for discussion and inspiration. As usual the group was informal, enthusiastic, and objective in its discussion of Society matters as related to the administrations of Sections. A more complete report of this conference is expected for a later issue.

The second of these regular features was the Student Chapter Conference, attended by a large group gathered from 22 colleges. The conference met both Wednesday afternoon and Thursday morning. On Wednesday the subjects dealt with included the graduate's immediate future and technical features of the Pensacola, Okla., Dam, while on Thursday a discussion of ethics was followed by discussion on, and formation of a Midcontinent Conference of Student Chapters, with nine Chapters as official charter members. At the luncheon following, presided over by a student officer, members and students united to round out a thoroughly worth-while conference.

Special preparations were made for entertaining the ladies. Every afternoon was provided for, leaving the mornings free for shopping or other interests. A special luncheon was arranged for Wednesday, after which the ladies enjoyed a visit to the Nelson Art Gallery. On Thursday there was a luncheon at the Mission Hills Country Club followed by bridge, and then by an automobile tour through the beautiful residential part of the city, with its parks and gardens. On Friday afternoon an automobile tour gave the ladies the opportunity to see other parts of the city, culminating in a stop at the University of Kansas City where tea was served. With all these varied arrangements for their enjoyment, the visiting ladies felt amply repaid for attendance at the Spring Meeting.

All the arrangements were handled by the able local committee. Each feature or function was allotted to a special group, and was efficiently prepared for and carried out. No detail was overlooked that might conduce to the comfort and enjoyment of those who attended.

Appointments of Society Representatives

C. E. Myers, M. Am. Soc. C.E., has been appointed the Society's representative on the Highway Research Board of the National Research Council. William N. Carey, M. Am. Soc. C.E., will serve as alternate to Colonel Myers.

E. R. Needles and C. M. Spofford, Members Am. Soc. C.E., have been appointed to represent the Society on the Hoover Medal Board of Award.

Society Meetings for 1941 Scheduled

Locations for Society Meetings during 1941 have been fixed. By action of the Board of Direction in Kansas City, the following schedule is made effective:

Spring Meeting—Baltimore, Md.
Annual (Summer) Convention—San Diego, Calif.
Fall Meeting—Chicago, Ill.

Selection follows a somewhat standard routine, based on the stated policy of the Board, favoring a rotation such that normally the Spring Meeting is assigned to the South and Southeast, the Annual Convention to the transmountain area, and the Fall Meeting to the Northeast. Formal invitations are submitted by Local Sections who may elect to sponsor a given meeting; these are analyzed and correlated by a Board committee which reports recommendations; and the final decision is by the Board. Such was the procedure that resulted in the choices for 1941.

Specific dates were not set; but the ordinary times would be April, July, and October. Decision thus early in the year is required by the necessity of conferring with local committees, in order to fix the final dates, to reserve hotel accommodations, and particularly to develop a program suitable for each city.

Society Aids Arizona Engineers

Accepts Local Section's Call to Make Salary Survey

The Society, acting as a disinterested party through the extensive services of one of its staff, has been privileged to aid in making a salary survey pertaining to engineering work in the Arizona State Highway Department. By invitation, Allen P. Richmond, M. Am. Soc. C.E., Assistant to the Secretary of the Society, spent the best part of two months on this assignment. From his report to the State Highway Department, the following significant summary has been drawn.

Under date of January 30, 1940, a resolution adopted by the Arizona Section set forth that the economic welfare of engineers in the Arizona Highway Department had been placed in jeopardy; and the State Highway Commission had offered to consider fairly and be guided by a disinterested study to be made by an outside qualified party. The Section then requested that the Society make a salary study and from such study recommend an equitable rate of compensation for the engineers on state highways.

Thus it happened that Mr. Richmond, with the assent of the Highway Commission, was delegated to go to Phoenix, Ariz., in the middle of February and make, first, a reconnaissance. This was soon completed; it indicated the need for, and the feasibility of, a thoroughgoing salary survey. Accordingly he was instructed to take the necessary time to complete this second and longer task.

The salary survey was conducted in three parts: first, to codify the engineers' work in the form of grade specifications with appropriate minimum requirements for performance; second, to match up the engineers with their proper basic classifications; and third, to suggest salaries to fit the grades. Comparisons were made with other available classifications, not only those of the Society but of other organizations—professional, federal, and state. Several weeks were spent on this phase and eventually the Arizona classifications were set up into six professional and four subprofessional grades.

The second part, relating to personnel allocations, was made difficult by lack of a local merit rating system. Instead, the principal executives in the Highway Department studied the grade specifications and rated their own men. Then the entire list was reviewed by the same department heads acting as a committee, and unified after discussion. This list was then submitted to the Commission with the recommendation that it be given further study to eliminate the personal equation.

Finally, a thorough study was made of all available salary ranges, nearby and distant. Thus, by study and comparison, salaries were assigned ranging from $80 to $225 per month for the four subprofessional grades, and from $165 to $700 per month for the six professional grades. In all these studies it was continually reiterated that Mr. Richmond, on behalf of the Society, was treating the matter objectively, without individuals in mind.

Specific recommendations were made to the Commission that it adopt the classification and salary ranges; arrange for allocation

of each of its engineers to a proper classification; insist that they be sufficiently qualified; and take steps to assure that they receive salaries commensurate with their qualifications.

Other supplementary recommendations had to do with the revision of titles of position, the preparation of an organization chart, and the institution of a merit system. In all these studies, extending from February 18 to April 2, Mr. Richmond was in close cooperation with the State Highway Engineer, W. R. Hutchins, Assoc. M. Am. Soc. C.E. In addition, Raymond A. Hill, M. Am. Soc. C.E., of Los Angeles, gave extended and intensive assistance. The entire procedure was carried on in close cooperation with C. T. Leeds, Director of that District.

It is too early to assess fully the value of this study or its eventual service to the Arizona engineers. However, as an effort in disinterested cooperation, it has been widely acclaimed and the Society is credited with a substantial contribution toward a worthwhile end.

Sewage Treatment Costs

Report of Committee of the Sanitary Engineering Division

THE COMMITTEE on Sewage Treatment Costs of the Sanitary Engineering Division has been considering its subject for the past two years. Following is a progress report with some brief general comments on certain phases of sewage treatment costs related to the proposed committee activity.

The costs of sewage treatment are intimately related to questions of (1) the degree of treatment needed, (2) the characteristics of the sewage and particularly the industrial wastes for each community, (3) the plant loadings and performance, (4) the available methods of financing (5) the skill exercised in operation, (6) the administrative supervision accorded the sewage works, and (7) other factors. It is not a simple task to select the aspect of the problem that should be given first consideration.

General Program

In the brief progress statement of January 1939 (CIVIL ENGINEERING for April 1939, page 247), two possibilities as to the scope of committee activity were suggested: the broad field of the economics of sewage disposal, or the assembling of cost data and forms for recording costs. The committee favored the first or broader scope.

Further consideration of the problem has developed the impression that the assembling of cost data, including a more or less standardized procedure for recording and analyzing such data, should be one of the early steps in the program directed toward a study of the economics of sewage disposal. Also, it seems desirable to consider enlisting the aid of other agencies such as the sewage works associations, the public health associations and officials, the operators and managers of sewage works, and, possibly, the officials of state and national municipal league organizations.

Accordingly the committee proposes, as a first step, an effort to formulate schedules for assembling and analyzing first costs of sewage treatment projects and for recording operating and total annual costs of operating installations. Such schedules would be useful to the plant operation and management personnel and of value to municipal authorities as well as to sanitary engineers. Therefore the viewpoints of these several groups must, in some manner, be given attention.

After the formulation of the proposed schedules and suggested procedures for putting them into use, some modification of the organization of the committee may be desirable. Perhaps the setting up of a joint committee may be considered for the purpose of extending the scope of the investigation of sewage treatment costs. At any rate, it is the present general plan of the committee to endeavor to develop the foregoing possibilities during 1940.

Previous Work by Other Agencies

Considerable work relative to costs and recording of costs has already been done by committees of other societies, which should be given careful attention and properly correlated with any program of this Society. The American Water Works Association has formulated a manual for water works accounting which should be helpful. Some years ago the New England Water Works Association proposed an earlier procedure for water works accounts which apparently has been used by certain New England water departments and a number of sewage departments.

In 1932 there was published in the *Sewage Works Journal* (Vol. IV, 1932, page 3) an excellent report on "Sewage Works Operating and Cost Records" by a committee of the Federation of Sewage Works Associations, which recommended that every sewage works should have an annual report and suggested the details which should be included.

Project Costs

The initial or original cost of a sewage treatment project includes a number of items:

1. Construction cost for structures and facilities, including errors, omissions, and contingencies.
2. Land, rights of way, and easements.
3. Engineering and inspection.
4. Preliminary or organization expenses.
5. Administration, legal, and overhead costs.
6. Interest during construction.

In addition to the initial cost of an improvement, a sewage treatment project often includes works constructed during previous years. It would seem that a determination of the reasonable value of these older sewerage elements should be included as a part of the total project cost.

PWA and WPA Construction

The construction of public works with federal grants in aid under the PWA, WPA, and other emergency agencies for un-

Forecast for May "Proceedings"

MASONRY DAMS: A SYMPOSIUM

Treatment of the general problem in a broad sense, including numerous "case histories."

BASIC DESIGN ASSUMPTIONS

By Ivan E. Houk and Kenneth B. Keener, Members Am. Soc. C.E.

A general introduction to the symposium, containing basic assumptions and related technical considerations involved in the design of high and important masonry dams.

DESIGN OF ARCH DAMS

By R. S. Lieurance

A presentation of coefficients and formulas for use in computing forces, moments, and radial deflections of uniform circular arches.

PREPARATION OF FOUNDATIONS

By Charles H. Paul and Joseph Jacobs, Members Am. Soc. C.E.

A practical discussion of problems pertaining to bearing capacity, bond, frictional resistance, and the control or reduction of uplift pressure, seepage, and scour.

GEOLOGICAL PROBLEMS

By Irving B. Crosby, Affiliate Am. Soc. C.E.

Demonstrating the importance of thorough and competent geological examinations preliminary to, and throughout the construction of, masonry dams.

CONCRETE CONTROL

By I. L. Tyler, M. Am. Soc. C.E.

A study of strength, weight, durability, and impermeability as applied to concrete for dams.

CONSTRUCTION JOINTS

By Byram W. Steele, Assoc. M. Am. Soc. C.E.

Carefully considered conclusions pertaining to cracks and construction joints in masonry dams based on tabular data describing 78 dams in the United States and abroad.

employment relief, has complicated the problem of determining sewage treatment costs. Construction costs have been increased by the relief features of the program, while on the other hand the costs to the community have been reduced by outright federal grants.

Construction costs by contract work under the PWA should represent reasonable cost units. It is not quite certain how the amount of the federal grant should be included in setting up a rate base for service charges.

It would seem that the costs of WPA and other essentially "made work" projects should not be included either at the actual costs or at the costs to the community, but at some estimated reasonable value of the completed project. Probably no uniform procedure can be determined that will be satisfactory to all communities, but possibly a procedure may be set up as a typical or recommended procedure.

Fixed Charges

The fixed charges, including interest on the capital account or investment, and depreciation of the capital account or investment, should be included in the total annual costs of sewage treatment. The fixed charges on projects constructed under grants of federal funds may be less than the fixed charges on similar projects built without such federal grants. This factor must be considered in any comparative study of costs of different projects.

Operation and Maintenance

Costs of operation and maintenance of sewage treatment works are variable and difficult to obtain on an accurate or comparative basis. Charge account schedules have been suggested, but probably each community has its peculiar system or lack of system for keeping a record of operation and maintenance costs.

The schedule on operation and maintenance costs proposed in the 1932 report of the Federation of Sewage Works Associations Committee suggested cost per million gallons of sewage treated and cost per capita of population as the two units for comparison of costs. These two units may not be sufficient to represent the performance of plants in different cities.

It would seem that the time has come when sanitary engineers and sewage plant operation and management personnel should endeavor to establish and popularize measurement units which more accurately represent performance than the quantity of sewage handled, or the population served.

Total Annual Costs

The total annual costs for sewage treatment, including fixed charges and operation and maintenance expense, comprise the items of most interest to the municipal administration. Tax levies or service charges must cover these costs. Accordingly, sewage treatment processes should be compared on the basis of these costs.

The amount of the tax levy or the service charge will be affected by the amount of fixed charges set up to cover interest on investment and depreciation. Where the investment is largely a grant from the federal government and no depreciation account is provided, a fictitiously low total annual cost may be indicated. Also, the fixed charges for new construction cover some unused capacity provided for future growth. Thus, some proportion of the fixed charges does not relate directly to the present performance of the treatment works. These two factors increase the complexity of the problem of setting up a logical procedure for analyzing sewage treatment costs and relating them to the extent of treatment provided.

Summary Statement

The progress made by the committee has been limited. The problem is complex and the time of committee members has been occupied by other pressing activities. The committee now suggests a continuation of its efforts directed primarily toward the formulation of a program and schedules for assembling costs and relating them to performance of sewage treatment facilities.

Respectfully submitted,

Committee on Sewage Treatment Costs
William E. Stanley, *Chairman*
R. A. Allton — George J. Schroepfer
Paul Hansen — A. H. Wieters

Report of Committee on Stresses in Railroad Track

As Submitted to the Board of Direction in January 1940

During the past year the Committee's staff of engineers under the direction of the chairmen (9 in all) have been engaged in field, laboratory, and office work. Through the summer extensive tests were made on the Pennsylvania Railroad in Delaware to obtain data on the action of driving wheels of locomotives of ten types made to slip and spin when run over track that had been made slippery, and also to find the effect of a mechanical oscillator having an unbalanced rotating weight applied to the main pin of the locomotive while at rest. Strain and movement records of the tests were obtained by means of elaborate electrical apparatus devised for the purpose. The study and interpretation of the data of the various field and laboratory tests have made excellent progress.

Summer observations were made on a long stretch of welded rail on the Bessemer and Lake Erie Railroad near Pittsburgh, Pa., and on another stretch of the Delaware and Hudson Railroad at Schenectady, N.Y. Observations have been continued on test track equipped with various types of joint bars on the Pennsylvania Railroad near Valparaiso, Ind., and on the Atchison, Topeka and Santa Fe Railway west of Streator, Ill.

An interesting feature of the laboratory work at the University of Illinois is the operation of a rolling load testing machine for repetitive loading of rail joints of diverse quality. During the year the test equipment has been increased considerably and new types of apparatus have been designed and built or purchased to permit extension of the scope and opportunities of the investigation on the action of track under the movement of locomotives and cars at both low and high speeds.

As heretofore, the research is being financed by the Association of American Railroads and reports are being made to the American Railway Engineering Association, the committee in charge being the joint committee of the American Railway Engineering Association and the American Society of Civil Engineers.

Respectfully submitted,
(*Signed*) A. N. Talbot
Chairman, Committee on Stresses in Railroad Track

A Quarter Century of the Engineering Foundation

Under the title, "Twenty-Five Years of Service," the Engineering Foundation, of which Otis E. Hovey, Hon. M. Am. Soc. C.E., is director, has issued an attractive brochure, outlining its history and activities. The appearance of this publication coincides with the completion of twenty-five years of philanthropic work originally begun by the late Ambrose Swasey, Hon. M. Am. Soc. C.E., in 1914. General organization and methods of operation are covered, including brief accounts of typical projects in the various engineering fields.

At present an income from almost one million dollars is being administered by the Foundation. Other funds, from an estate now in process of being settled, are expected to materialize. In all, the Foundation has been privileged to distribute over $400,000 to assist valuable research, largely but not wholly through the Founder Societies. These societies, as well as similar organizations and industrial groups, also made contributions to the work in the form of funds, materials, and other aid. In these years, 73 separate projects have been assisted to the extent of over three million dollars, including the value of supervision over research.

Among the projects furthered by the Foundation, which are of special interest to the Society, are the following:

Concrete and Reinforced Concrete Arches. About 12 years of work under a Society committee of which Clyde T. Morris, M. Am. Soc. C.E., was chairman, resulted in a final report published in the 1935 Transactions.

Arch Dam Investigation. This occupied about 11 years and cost about $200,000. It was under the chairmanship of Charles Derleth, M. Am. Soc. C.E., and then that of the late Charles D. Marx, Hon. M. Am. Soc. C.E. The first report, a volume of 285 pages, was published in the May 1928 Proceedings; Vols. 2 and 3 were published by the Engineering Foundation.

Steel Columns. Something less than 10 years was spent on this research by a Society committee headed by F. E. Turneaure, Hon. M. Am. Soc. C.E. After a number of progress reports, the final report appeared in the 1933 TRANSACTIONS.

Earths and Foundations. This work, under a special Society committee headed by Lazarus White, M. Am. Soc. C.E., was later assumed by the Soil Mechanics and Foundations Division, under Carlton S. Proctor, M. Am. Soc. C.E., chairman. Many progress reports and articles have been published in the Society's PROCEEDINGS and TRANSACTIONS. The work is continuing.

Hydraulic Researches. Since 1936 extensive grants have been made to the work of the Society's Committee on Hydraulic Research, under J. C. Stevens, M. Am. Soc. C.E., as chairman. The latest progress report in the March 1940 CIVIL ENGINEERING indicated 12 specific projects under investigation, of which 7 are being assisted by the Foundation.

The foregoing is only a brief summary of the many worth-while accomplishments noted in this booklet. For an account of the current projects in the civil engineering field to which the Engineering Foundation is contributing, reference may be made to CIVIL ENGINEERING for December 1939, page 753.

Don Johnstone Resigns

AFTER ALMOST FIVE years of work with the Society, during the latter two years of which he has been in charge of the editing of CIVIL ENGINEERING, Don Johnstone, Assoc. M. Am. Soc. C.E., resigned as of April 1 to accept a position as assistant professor at Ohio State University.

In the course of his work with the Society, Mr. Johnstone was helpful in editing reports and manuals, but his major efforts were confined to CIVIL ENGINEERING. This work he organized to advantage, continuing to maintain its high standards.

While in New York, Mr. Johnstone was also interested in other activities. He was a lieutenant, j. g., in the Naval Reserve and was prominent in the Metropolitan Section's Junior Branch, of which he was president for 1937–1938.

As he takes up his new duties, he carries the best wishes of his associates at Headquarters, as well as of a large number of other friends in the Society.

Arrangements have been made whereby the editorship of CIVIL ENGINEERING will be taken over in July by Donald P. Barnes, Assoc. M. Am. Soc. C.E. His experience and qualifications for this position will be covered in a later issue.

Denver Prepares for Annual (Summer) Convention

PLANS ARE developing rapidly for a splendid Society Convention in Denver this summer. The time is set for July 24–26, and the headquarters will be at the Hotel Brown Palace.

With the engineering headquarters of the Bureau of Reclamation in Denver, it is natural that reclamation and irrigation should have a major place on the program. But this will not be to the exclusion of other important interests. Seven of the Society's Divisions are planning technical sessions, to provide varied programs of interest to all engineers. Picturesque surroundings and delightful summer weather should combine to make this Convention both comfortable and enjoyable.

Historic and scenic features of the vicinity will be recognized in an assortment of trips and social events. These will dovetail in with the technical sessions to give a pleasing variety to the entire meeting.

A special pre-Convention tour is being planned, following the general pattern that has proved so successful in years past. This time the special party will gather at Chicago or Omaha, as convenient, and proceed together by the Burlington Railroad to the Black Hills. There part of three days will be spent in sightseeing by automobile, to visit Mount Coolidge, Mount Rushmore, with its spectacular memorial carved out of the rocky cliffs, Rapid City, Deadwood, and other scenic spots in this lovely country. By train the party will then proceed to Denver, arriving in time for additional side trips through the Rocky Mountains before the Convention begins. Further details of this attractive tour and of the Convention program will be given in subsequent issues.

American Engineering Council

The Washington Embassy for Engineers, the National Representative of a Large Number of National, State, and Local Engineering Societies in 40 States

ANTI-TRUST DRIVE GAINS NEW GROUND

A NUMBER of recent developments have given encouragement to the campaign which Thurman Arnold, head of the anti-trust division of the U.S. Department of Justice, is currently conducting to enforce a fuller degree of competition and eliminate price rigidities. In a highly important decision with many implications for other industries, the U.S. Supreme Court ruled unanimously (two justices not participating) that the Ethyl Gasoline Corporation has exercised an unlawful control over gasoline prices through its handling of licenses for the sale of fuels containing its product.

In the building industry, where a number of actions are already awaiting trial, a new indictment was returned in Cleveland against a large part of the plumbing industry, naming 102 defendants including manufacturers, jobbers, and labor organizations. The grand jury charged that these defendants had conspired to effect a restricted system of distribution for plumbing supplies and equipment and boycotted and blacklisted those who refused to conform.

Labor unions were held subject to the provisions of the Sherman Antitrust Act in a decision by the U.S. District Court for the District of Columbia, in a case arising out of a jurisdictional dispute between two unions seeking control over the drivers of mixer-trucks transporting concrete. A final decision on this disputed point is expected soon in the case of the Apex Hosiery Company of Philadelphia, which is suing a labor union for triple damages for "restraint of trade" resulting from a strike. The case is now pending before the Supreme Court. Although the American Federation of Labor has consistently argued that "human labor is not an article of commerce" a brief in the Apex case filed by the Committee on Industrial Organization contents itself with the statement that "unions are not subject to the anti-trust laws unless they become part of a combination of employers which commits acts in violation" of such acts.

A recent decision of the District of Columbia Court of Appeals holding the American Medical Association and other organizations subject to the Sherman Act will shortly be appealed to the U.S. Supreme Court for final adjudication.

PERSONNEL SELECTED FOR A.E.C. COMMITTEES

Many prominent engineers have accepted invitations by President Alonzo J. Hammond to serve on the various committees of American Engineering Council for the year 1940, which will be made up as follows:

Standing Committees

Constitution, By-Laws and Standing Rules: Chairman, Edwin F. Wendt, consulting engineer, Pittsburgh, Pa.; Leon P. Alford, Department of Industrial Engineering, New York University; A. W. Berresford, consulting engineer, New York City; J. K. Finch, Renwick professor of civil engineering, Columbia University; Henry Earle Riggs, honorary professor of civil engineering, University of Michigan; Edgar K. Ruth, consulting engineer, Cincinnati, Ohio; R. W. Trullinger, assistant chief, Office of Experiment Stations, U.S. Department of Agriculture.

Engineering and Allied Technical Professions: Chairman, C. O. Bickelhaupt, assistant vice-president, American Telephone and Telegraph Company, New York City; W. W. DeBerard, associate editor, *Engineering News-Record*, Chicago; C. J. Freund, dean of the College of Engineering, University of Detroit; A. H. Lovell, assistant dean and secretary, College of Engineering, University of Michigan; Daniel C. Walser, vice-president, Charles B. Hawley Engineering Corporation, Washington, D.C.

Finance: Chairman, F. Malcolm Farmer, vice-president and chief engineer, Electrical Testing Laboratories, Inc., New York City; William L. Batt, president, SKF Industries, Inc., Philadelphia; Harold V. Coes, partner, Ford, Bacon and Davis, Inc., New York City; Leonard J. Fletcher, assistant general sales manager,

Caterpillar Tractor Company, Peoria, Ill.; John P. Hogan, partner, Parsons, Klapp, Brinckerhoff and Douglas, New York City.

Membership and Representation: Chairman, Warner Seely, secretary, Warner and Swasey Company, Cleveland; O. L. Angevine, executive secretary, Rochester Engineering Society; C. O. Bickelhaupt, George H. Fenkell, consulting engineer, Almont, Mich.; Edwin F. Wendt.

Publicity and Publications: Chairman, Eugene W. O'Brien, vice-president, W. R. C. Smith Publishing Company, Atlanta; G. Ross Henninger, editor, *Electrical Engineering*, New York City; Raymond Olney, secretary-treasurer, American Society of Agricultural Engineers; George A. Stetson, editor, *Mechanical Engineering*, New York City; Sydney Wilmot, manager of publications, American Society of Civil Engineers. Advisory members of this committee are: Frank M. McCausland, publicity representative, Westinghouse Electric and Manufacturing Company, New York City; Robert Potter, *Science Service*, Washington, D.C.; Paul Wooton, Washington correspondent, McGraw-Hill Publishing Company.

Regional Activities: Chairman, James R. Withrow, head, Department of Chemical Engineering, Ohio State University; Wayne Clark, office engineer, Duluth, Missabe and Northern Railway, Duluth; George H. Fenkell; Louis C. Marburg, treasurer, Marburg Brothers, Inc., New York City; D. Lee Narver, vice-president, Holmes and Narver, Inc., Los Angeles; Lewis M. Smith, chief electrical engineer, Alabama Power Company, Birmingham; S. S. Steinberg, dean, College of Engineering, University of Maryland.

Public Affairs: Chairman, Alvan L. Davis, secretary-treasurer, The Bennett Metal Treating Company, Waterbury, Conn.; George W. Burpee, consulting engineer, Coverdale and Colpitts, New York City; J. F. Coleman, consulting engineer, New Orleans; John S. Dodds, professor of civil engineering, Iowa State College; Frederick H. Dorner, consulting mechanical engineer, Milwaukee, Wis.; C. Francis Harding, head, School of Electrical Engineering, Purdue University; Dugald C. Jackson, professor emeritus, Massachusetts Institute of Technology; Warren H. McBryde, consulting engineer, San Francisco; Andrey A. Potter, dean, Schools of Engineering, Purdue University; D. H. Sawyer, Public Buildings Administration, Federal Works Agency; C. E. Stephens, vice-president, Westinghouse Electric and Manufacturing Company, New York City.

Special Committees

Patents: Chairman, Andrey A. Potter; Kenneth H. Condit, executive assistant to the president, The Conference Board, New York City; James H. Critchett, general manager, Union Carbide and Carbon Research Laboratories, Inc., New York City; William M. Grosvenor, consulting chemist and factory engineer, New York City; Frank B. Jewett, president, Bell Telephone Laboratories, Inc., New York City; Warner Seely.

Public Works: Chairman, George W. Burpee; J. F. Coleman; Herbert S. Crocker, consulting civil engineer, Denver, Colo.; G. F. McDougall, president, G. F. McDougall Company, Portland, Ore.; Thomas S. McEwan, consulting engineer, Stevenson, Jordan and Harrison, Chicago; I. E. Moultrop, consulting engineer, Belmont, Mass.

Surveys and Maps: Chairman, John S. Dodds; William Bowie, editor, *The Military Engineer*, Washington, D.C.; George C. Branner, State Geologist, Little Rock, Ark.; G. R. Smiley, chief engineer, L. & N. Railway Co., Louisville, Ky.; S. S. Steinberg; Robert L. Sumwalt, professor of civil engineering, University of South Carolina.

Engineering Economics: Chairman, Leonard J. Fletcher; Leon P. Alford; Harvey N. Davis, president, Stevens Institute of Technology; Frederick M. Feiker, dean, School of Engineering, George Washington University; Ralph E. Flanders, president, Jones and Lamson Machine Company, Springfield, Vt.; Dugald C. Jackson; William McClellan, president, Union Electric Company, St. Louis; Henry Earle Riggs; L. W. Wallace, director of engineering and research, The Crane Company, Chicago.

Inter-American Engineering Relations: Chairman, C. O. Bickelhaupt. Balance of membership still to be selected.

A.E.C. Representatives on Other Bodies

Advisory Council, Federal Board of Surveys and Maps: John S. Dodds.

Joint Conference on Standard Construction Contracts: Thomas H. Urdahl, consulting engineer, Washington, D.C.

American Documentation Institute: C. H. Birdseye, chief, Division of Engraving and Printing, U.S. Geological Survey.

National Advisory Council to the Committee on Patents, House of Representatives: Kenneth H. Condit.

National Bureau of Economic Research: Frederick M. Feiker.

American Association for the Advancement of Science: Frederick M. Feiker.

Society for the Promotion of Engineering Education: Frederick M. Feiker.

Patent Inquiry Completed

Following nearly a year of intensive study of the American patent system, the staff of the Joint Patent Inquiry, sponsored by the National Association of Manufacturers, the Conference Board, and American Engineering Council, on March 15 completed its work with the submission of a lengthy report to the three organizations.

Among the topics discussed are the changing sources of invention and the rising importance of the industrial research laboratory; the social and economic benefits of invention; patent procedures and practices; industry's use of patents; evolutionary changes in the patent system and their effects upon the inventor, industry, and the public; and the merits and drawbacks of proposed reforms.

Power Grid Proposed for Eastern United States

After nearly two years of study by the National Defense Power Committee and its successor, the National Power Policy Committee, a definite plan for the linking of power generating and load centers in the northeastern section of the United States has been prepared and submitted for comment to the leading utility companies operating in the area concerned.

The plan envisions the construction by the government of a series of 275,000-v circuits connecting the following cities:

Washington and Baltimore with Boston, via Philadelphia, New York City, and Bridgeport.

Philadelphia and Pittsburgh.

New York City and Cleveland via Binghamton, Syracuse, and Buffalo.

Pittsburgh and Chicago via Cincinnati and Indianapolis.

Pittsburgh and Chicago via Cleveland and Toledo, with a branch to Detroit.

Chicago and St. Louis via Powerton.

Chicago and Milwaukee.

Approximately 2,500 miles of line would be involved, with a total estimated cost of \$190,000,000, including \$70,000,000 for transformers and \$50,000,000 for connections with present operating systems. Annual operating costs would amount to about \$13,000,000, of which some \$9,000,000 would be met by revenues for the use of various parts of the system to interchange power.

Proponents of the plan argue that it is necessary to assure to the heavy industrialized section of the country sufficient flexibility in the use of power resources to meet a war emergency, although it would also have peace-time use as a means of meeting local power peaks and utilizing the more efficient generating plants. Under war conditions it is estimated that there would be a deficiency in generating capacity in the area of 1,500,000 kw, although this figure is questioned by experts in the utility industry.

The twenty major utility companies operating in the area have been asked to cooperate in making the plan effective, although the exact extent of such cooperation is yet to be determined. Management of the system would be in the hands of a new governmental agency, which would probably have the name of "United States Power Authority," and which would be authorized to borrow money, construct and operate the lines and substations, and enter into contracts with both private and public operating utility companies. Creation of such a body would require new legislation and a bill to this effect will shortly be introduced in Congress. Necessary funds would be furnished by the federal government, either by direct appropriation or through the Reconstruction Finance Corporation.

Pan-American Relations Promoted by Council

As the result of the interest in stimulating relations with the countries of Central and South America stirred up by discussion at the Twentieth Annual Assembly of American Engineering Council last January, two tangible accomplishments have already materialized. The Farm Equipment Institute Seminar, to be

held in September 1940, will reserve places for six Pan-American representatives; and Council itself is forming a new Committee on Inter-American Engineering Relations.

The Seminar, which is sponsored by a group of agricultural machinery manufacturers with the cooperation of the American Society of Agricultural Engineers, comprises a group of 112 agricultural students and instructors which are conducted on a one-week tour of industrial establishments making farm equipment as guests of the manufacturers. The Six Pan-American participants will be selected by the U.S. Department of State as representatives of agricultural schools in as many countries.

Council's new committee, the formation of which has been approved by the Executive Committee, will not only facilitate the completion of arrangements with the State Department in regard to the Seminar, but will also function as a standing committee to improve contacts between engineers of the nations within this hemisphere. Suggested subjects for action include the exchange of students, lecturers, and professors; the development of conferences and correspondence among organized engineering groups in the various countries; and possibly the promotion of a Pan-American Engineering Congress at some future date.

Celebrate 150th Year of Patent Law

By action of Congress and President Roosevelt, April 10, 1940, was designated Inventors and Patents Day to commemorate the sesquicentennial of the approval of the first patent law of the United States, signed by President George Washington on April 10, 1790.

The occasion was marked by a large dinner in Washington, attended by about a thousand leaders of industry, science, government, and the patent bar. Invitations were issued to the entire membership of the A.E.C. executive and patents committees, and the dinner was attended by President Alonzo J. Hammond, Vice-President William L. Batt, and Executive Secretary Frederick M. Feiker.

As part of the celebration the Patent Office kept open house for the entire week, and staged a "Parade of Inventions," specially prepared exhibits depicting the development of industrial products from medieval times to the present.

T.N.E.C. Opens Hearings on Technologic Changes

On April 8 the Temporary National Economic Committee began a new series of hearings, expected to extend over a period of some three weeks, to develop information on the broad subject of technological change and its effect upon employment and production. Invited to testify were over 40 leaders of science, industry, and organized labor in the fields of automobile manufacture, steel, coal, railroads, textiles, communications, office appliances, agriculture, and vocational and consumers' education.

In announcing the hearing, Senator Joseph C. O'Mahoney, chairman of the committee, pointed out: "Without modern technology, mass production would not be possible; it is technology which has enabled industry to organize into great concentrated units of production and distribution. Technology has created many new industries and has provided many new opportunities for labor, though at the same time it has unquestionably displaced many workers. The Committee plans to study seriously the impact of technology in all its implications, what it means in terms of employment, of unused capital, of the effective organization of our nation's resources."

The chairman also made it clear that the Committee entered its task with no pre-formed judgments, and that the hearings were not intended to express support for his recently introduced bill to provide a system of rewards and contributions for the greater utilization of labor in industrial production through the taxing of machines.

Last month the T.N.E.C. completed a series of hearings on the effects of various state regulations upon interstate commerce.

New Developments Mark Aviation Progress

Three recent accomplishments in the field of aviation emphasize the speed with which technology in this field is progressing, and give point to the argument of Army and Navy officials that they will lose nothing by yielding temporary priority to foreign nations in the delivery of aircraft orders.

The U.S. Navy, it has recently been disclosed, has under construction by the Glenn L. Martin Company, Baltimore, a giant "flying houseboat" that will weigh nearly 84 tons, carry a useful load of 32 tons, and be capable of a non-stop flight of over 12,000 miles. This machine slightly surpasses the Army's biggest ship, also under construction, which will have a gross weight of 70 tons and a useful load of 28 tons. Both planes will be more than twice the size of the Army's famed "flying fortresses."

Although details of the power plants to be used were not made public, aviation experts link the new planes with the recent development by the Wright Aeronautical Corporation of a new nine-cylinder air-cooled motor rated at 1,200 hp, or approximately one horsepower for each pound of its weight.

A third notable development was the successful completion on April 6 of a 300-mile all-blind flight in an Army bombing plane from Mitchel Field, N.Y., to Langley Field, Va. The four-motor, $22^1/_2$-ton machine was guided entirely through instruments, with the pilot hooded, from before the take-off until after the landing.

Washington, D.C.
April 11, 1940

News of Local Sections

Scheduled Meetings

Cleveland Section—Dinner meeting held jointly with the Case, Ohio Northern, and University of Akron Student Chapters at the Case Club on May 10.

Colorado Section—Dinner meeting at the University Club on May 13, at 6:30 p.m.

Dayton Section—Joint meeting at the University of Dayton on the evening of May 20 (date and time tentative).

Georgia Section—Luncheon meeting at the Atlantan Hotel on May 13, at 12:30 p.m.

Indiana Section—Dinner meeting held jointly with the Purdue University Student Chapter in the Union Building at Purdue on May 2, at 7 p.m.

Los Angeles Section—Dinner meeting arranged by the Student Chapter at California Institute of Technology in Pasadena on May 8, at 6:30 p.m.

Metropolitan Section—Annual meeting in the Engineering Societies Building in New York, on May 15, at 8 p.m.

Miami Section—Dinner meeting at the Alcazar Hotel on May 2, at 7 p.m.

Philadelphia Section—Meeting preceded by good-fellowship dinner at the Engineers Club on May 14, at 6 p.m.

Sacramento Section—Regular luncheon meetings at the Elks Club every Tuesday at 12:10 p.m.

St. Louis Section—Luncheon meeting at the York on May 27, at 12:15 p.m.

San Francisco Section—Dinner meeting of the Junior Forum at the Engineers Club on May 28, at 5:45 p.m.

Spokane Section—Luncheon meeting at the Davenport Hotel on May 10, at 12 noon; inspection trip to Grand Coulee Dam on May 18.

Syracuse Section—Annual dinner meeting at Drumlin's Country Club on May 7, at 6:30 p.m. Senior civil engineering students at Syracuse University will be guests of the Section.

Tennessee Valley Section—Spring meeting at Hiwassee Dam, N.C., on May 3 and 4.

Wisconsin Section—Dinner meeting at the City Club in Milwaukee on May 9, at 6:30 p.m.

Recent Activities

Central Ohio Section—*Columbus, January 25 and February 19:* At the first of these sessions Edgar L. Weinland, member of the Columbus Metropolitan Housing Authority, gave a talk on the purpose of the settlement work being done in the city by the Au-

thority. A lively discussion followed. The guest of honor at the February meeting was Walter E. Jessup, Field Secretary of the Society, who described the professional welfare activities of the Society. A general discussion of the work of American Engineering Council concluded the program.

CINCINNATI SECTION—*Dayton, March 16:* Representatives of the Section met other Local Section and Student Chapter representatives in the District at a special luncheon held for the purpose of discussing the Fall Meeting of the Society, which will take place in Cincinnati in October. Vice-President Davis and Director Root were present and addressed the gathering.

CLEVELAND SECTION—*March 5:* The principal speaker at this luncheon meeting was John Berry, commissioner of the Cleveland Airport. Major Berry discussed the operation of the airport, which was the first in the world to be municipally owned and operated. Following his talk, a representative of the American Airlines showed a motion picture on the subject of travel by air.

COLORADO SECTION—*Denver, March 11:* A talk on the vocational guidance work of the Educational Coordinating Committee of American Engineering Council initiated the technical program. Then Howard F. Engler, of the Air Corps Technical School at Denver, explained the purpose and function of the school and showed slides illustrating its growth and development. *Junior Association:* The Association announces that it has held two meetings in recent months, the speakers being F. A. Banks, William I. Brown, and Marsh Beall, all on the staff of the U. S. Bureau of Reclamation. The two latter showed motion pictures they had made themselves.

CONNECTICUT SECTION—*Hartford, March 28:* The Juniors in the Section entertained the other members with a dinner and technical program. J. H. L. Giles, of the Connecticut State Department of Health, was chairman of arrangements, while the following Juniors participated in the technical program: William T. Dorrance, Jr., senior engineering aid in the Connecticut State Highway Department; A. J. M. Giardini, superintendent for Wadhams, May and Carey, of Hartford; and Earl R. Howard, assistant engineer of the Hartford Metropolitan District Commission.

DAYTON SECTION—*March 18:* Following a luncheon, A. F. Unckrich, district engineer for the Portland Cement Association, presented an illustrated lecture on "Soil Cement Pavements."

DISTRICT OF COLUMBIA—*Washington, March 16:* "Do the Railroads of the United States Face Nationalization?" was the subject of a widely attended debate held at this time. William J. Wilgus, Honorary Member of the Society and railroad authority, upheld the affirmative, while M. J. Gormley, executive assistant for the Association of American Railroads, was spokesman for the negative. Otto S. Beyer, chairman of the National Mediation Board, served as mediator. A panel of qualified representatives of different phases of the railroad transportation industry sat with the speakers and asked questions from their respective points of view when they seemed necessary for a better understanding of the subject. The field of ownership was represented by Cassius Clay; management, by Robert Henry; labor, by J. G. Luhrsen; shipping, by Thomas Lyons and Ralph L. Dewey; and the public, by B. H. Meyer and Alvin B. Barber.

GEORGIA SECTION—*Atlanta, March 11:* A report on the Annual Meeting of the Society was presented by Commander L. F. Bellinger. This was followed by a talk on the research involved in plans for a salt water barrier in San Francisco Bay, which was given by Curtis A. Mees, consulting engineer of Atlanta. *April 8:* W. C. Caye briefly reviewed recent developments in the field of dirt-moving equipment. A film showing the latest types of equipment in operation was then presented.

KANSAS CITY SECTION—*March 28:* An amusing feature of the occasion was a contest in which the members were quizzed concerning their knowledge of Kansas City, the object being to make them well-informed hosts for the Spring Meeting. The technical program consisted of a motion picture, showing a complete tour through the Sheffield Steel Plant, one of Kansas City's largest industries.

KANSAS STATE SECTION—*Topeka, March 25:* Several Local Section officers spoke briefly on the Spring Meeting to be held in Kansas City. Then Field Secretary Jessup analyzed the results of the questionnaire on salaries, which was conducted by the Society.

KENTUCKY SECTION—*Louisville, March 22:* In the afternoon W. W. Saunders conducted the members about the 14th Street grade separation project. At the dinner meeting that followed the inspection trip the speakers were J. E. Root, Director of the Society, and James Wilson, chief engineer of the city of Louisville. The latter read a paper on the design and construction of the separation project viewed in the afternoon.

LOS ANGELES SECTION—*March 13:* A symposium on railroad engineering was presented by W. R. Armstrong, retired railroad engineer, who spoke on "Flood Protection on the Union Pacific"; M. C. Blanchard, chief engineer for the Coast Lines of the Atchison, Topeka and Santa Fe railroad, whose subject was "Improvements in Road Bed on the Santa Fe for Operation of High Speed Trains"; and V. S. Harrington, of the General Electric Company, who showed motion pictures and slides of the new steam turbine locomotive built for the Union Pacific.

MARYLAND SECTION—*Baltimore, March 26:* The technical program was in the hands of the Juniors in the Section, the first speaker being J. M. Coan, Jr., who read the final report of the Society's Committee on Juniors. Harry F. Page, Jr., then discussed "The Work to Be Done with Juniors," emphasizing the necessity of proper placement. He was followed by Adam Sack whose subject was "Work to Be Done with Employers." There was considerable discussion of both talks. *Junior Association, February 27:* The usual order of business was dispensed with in order to give more time to Prof. A. G. Christie, chairman of the Maryland State Board for the Registration of Engineers and Land Surveyors, who discussed various parts of the registration act.

METROPOLITAN SECTION—*March 20:* "Floods and Flood Control" was the subject of discussion, the principal speaker being William P. Creager, consulting hydraulic engineer of Buffalo, N.Y. Mr. Creager outlined methods of determining the economic justification of flood control projects, illustrating his lecture with moving pictures of the 1936 Pittsburgh flood.

MIAMI SECTION—*March 7:* The guest speaker on this occasion was B. M. Duncan, chief engineer and general manager of the Overseas Highway (U.S. No. 1—from Miami to Key West). Mr. Duncan, who was instrumental in the construction of this project, discussed "The Use of Local Material for Concrete Aggregate." *April 4:* A talk on the new Miami airport, which will be ready for service in January 1941, was given by Capt. John A. Price, aviation executive for the city of Miami.

MOHAWK-HUDSON SECTION—*Albany, N.Y., March 25:* John P. Hogan, President of the Society, and George T. Seabury, Secretary, were the guests of honor and principal speakers. Colonel Hogan discussed the growth of the Society and made optimistic prophecies for a more prosperous future, while Mr. Seabury reviewed some of the recent activities of the Society, which has recently stepped out of its original technical character and entered upon more active participation in professional matters. Director Arthur W. Harrington was also present.

NASHVILLE SECTION—*April 2:* A talk on the design and construction of barges was the feature of the technical program. This was given by Harry B. Dyer, vice-president of the Nashville Bridge Company.

NEBRASKA SECTION—*Omaha, March 9:* John G. Mason, bridge engineer for the Nebraska State Department of Roads and Irrigation, discussed the subject of the Engineers' Council for Professional Development in its relationship to the Nebraska Section. *March 28:* A special dinner meeting was arranged in honor of Field Secretary Jessup who was in the region. Mr. Jessup spoke on the activities of the Society, and a general discussion followed.

NEW MEXICO SECTION—*Santa Fe, March 13:* The technical program consisted of the presentation of a paper outlining the work and problems connected with the Pecos River Joint Investigation. This was given by Harlowe W. Stafford, engineer in charge of the investigation.

NORTHEASTERN SECTION—*Junior Association, Cambridge, Mass., February 27:* The Junior Association formally adopted its constitution at a dinner meeting held at this time. H. G. Protze, chairman of the committee for the formation of the Association, gave a report on the history of the organization, after which the following officers were elected: H. G. Protze, president; A. R. Anderson, vice-president; and P. C. Grueter, secretary-treasurer.

Mr. Grueter then presented a short paper on "Model Studies of the Cape Cod Canal and Approaches."

NORTHWESTERN SECTION—*St. Paul, April 1:* W. G. Hoyt, hydraulic engineer for the U.S. Geological Survey in Washington, D.C., spoke on "Current Puzzling Features of Hydrology." He was followed by Adolph Meyer, consulting engineer of Minneapolis, and E. V. Willard, chief engineer of the Minnesota State Department of Conservation, both of whom discussed his talk. Field Secretary Jessup was also present and spoke briefly.

OREGON SECTION—*Portland, March 12:* An impromptu luncheon meeting was arranged in honor of Joseph Jacobs, Vice-President of the Society, who happened to be in town. Mr. Jacobs reported on the business discussed at the Annual Meeting. *March 28:* A symposium on highways was presented by engineers on the staff of the Public Roads Administration. Those participating were R. B. Wright, who discussed "National Forest, National Park, and Federal Aid on Highways and Bridges"; H. B. Stanley, who spoke on the Highway Planning Survey; T. M. Davis, whose subject was "Federal Aid Cooperation with the States"; and R. M. Schwegler, who discussed highway materials and pavements. A motion picture describing the work of the Public Roads Administration concluded the technical program.

PHILADELPHIA SECTION—*March 12:* Joint meeting with the Philadelphia chapter of the American Public Works Association. Housing was the topic of discussion, the first three speakers being connected with the Philadelphia Housing Authority. These were James B. Kelly, who talked on aspects of low-rent housing; Walter H. Thomas, whose subject was the design of low-rent housing; and A. Ernest D'Ambly, who spoke on the mechanical design of low-rent housing. Following this presentation of the general problem of housing, Louis H. Doane, consulting structural engineer of Philadelphia, and W. R. Heritage read papers on the Glenwood Housing Project now under construction by the Philadelphia Housing Authority. A description of the Tasker Housing Project—presented by Chester I. Duncan and H. C. Turner, Jr.—concluded the scheduled presentations. Then Charles A. Flanagan, W. Pope Barney, William H. Gravell, and J. Edward Hutchison discussed the main papers.

PITTSBURGH SECTION—*February 27 and March 5:* Joint meetings with the Engineers' Society of Western Pennsylvania. An illustrated lecture on the "Diversion of Rivers During Construction" was presented at the first of these sessions, the speaker being A. J. Ackerman, director of engineering for the Dravo Corporation. The speaker at the second meeting was Don R. Berlin, chief engineer of the Curtiss Aeroplane Division of the Curtiss Wright Corporation, whose subject was "Some of the Problems Confronting the Airplane Designer." Sound motion pictures showing the processes of manufacture in the Curtiss factory supplemented the paper.

ROCHESTER SECTION—*March 21:* Joint meeting with the Rochester Engineering Society. Earl F. Church, professor of photogrammetry at Syracuse University, gave an illustrated lecture on aerial mapping. A dinner in honor of the speaker preceded the meeting. *March 27:* Discussion of Society affairs with President Hogan, Secretary Seabury, and Director Harrington was the feature of the occasion. Colonel Hogan also spoke on his recent trip to South America.

SACRAMENTO SECTION—*March 5, 12, 19, 26:* A sound film on the manufacture of glass was furnished by the Libbey-Owens-Ford Glass Company at the first of these luncheons, and J. G. Mackenzie, district sales manager of the company, described some new types of glass. Those addressing the other gatherings were F. J. Veihmeyer, professor of irrigation investigation at the University of California; Almon E. Roth, president of the San Francisco Employers Council; and A. B. Willett, structural engineer for the State of California Department of Public Works. *Junior Forum, March 13:* A talk on "Imperial Valley and the All-American Canal" was given by J. A. Conwell, assistant hydraulic engineer with the Division of Water Resources of the State Department of Public Works.

ST. LOUIS SECTION—*March 25:* S. L. Wonson and A. A. Miller, both on the staff of the Missouri Pacific, discussed "The Eagle," the new train recently put in service by this railroad. It was announced that Harold B. Lockett, of Washington University, and Robert N. Lorance, of the Missouri School of Mines and Metallurgy, were the recipients of the Section's awards to this year's outstanding civil engineering graduates.

SAN DIEGO SECTION—*March 28:* "The Duties of the Public Administrator and County Coroner" was the subject of an address given by William Glenn, assistant district attorney of San Diego County.

SEATTLE SECTION—*March 26:* The Section sponsored the fifteenth annual joint meeting and inspection trip of local groups of the Four Founder Societies. During the afternoon the members and their guests viewed the progress of construction on the Lake Washington Pontoon Bridge. Following a dinner in the evening, talks on the bridge were given by L. V. Murrow, state director of highways; R. B. McMinn, of the Public Roads Administration; and Charles E. Andrew, principal consulting engineer for the Washington Toll Bridge Authority.

SPOKANE SECTION—*February 9 and March 8:* Both of these regular luncheon meetings were devoted to business discussion and to making plans for future technical sessions.

SYRACUSE SECTION—*March 11:* Joint meeting with the Technology Club of Syracuse. The speaker was Maurice P. Davidson, trustee of the New York State Power Authority, who gave an illustrated lecture on the St. Lawrence Waterway and Power Project. Preceding the lecture, the Section entertained Mr. Davidson at a dinner, at which he spoke briefly.

TACOMA SECTION—*Olympia, March 12:* A paper on "Fatigue in Steel" was presented by George Huck, metallurgical engineer for the Bethlehem Steel Company.

TENNESSEE VALLEY SECTION—*Chattanooga Sub-Section, March 19:* The technical program consisted of reading and discussing a paper entitled "Value of Flood Height Reduction from the Tennessee Valley Authority Reservoirs to the Alluvial Valley of the Lower Mississippi." This was given by Charles W. Okey, principal civil engineer of the Tennessee Valley Authority. *Knoxville Sub-Section:* Since this was "Junior Night" the meeting was turned over to H. D. Southerland, Jr., who introduced the speakers. C. E. Kindsvater gave an illustrated lecture on the hydraulic laboratory model tests in connection with the Pickwick Landing lock-wall extension and floating boom, and A. J. Peterka spoke on the Kentucky and Watts Bar lock-filling systems. Both are connected with the Tennessee Valley Authority.

TOLEDO SECTION—*March 1:* J. Arthur MacLean, curator of oriental art at the Toledo Museum of Art, presented an illustrated lecture on "Man-Made Cave Temples of India," in which he described the art of frescoing and ancient knowledge of structural features. A lively discussion concluded the program. *March 8:* An inspection trip through the new water-supply tunnel under the Maumee River was the feature of the occasion. James Lynch, division engineer for Greeley and Hansen on the Lake Water Supply Project, conducted the trip.

TRI-CITY SECTION—*Rock Island, Ill., March 22:* Joint meeting with the Blackhawk Chapter of the Illinois Society of Engineers. The guest speakers were Harold E. Babbitt, professor of sanitary engineering at the University of Illinois, and Loran D. Gayton, city engineer of Chicago. Professor Babbitt's subject was "Expanding Professionalism," while Mr. Gayton gave an illustrated talk on "Underground Chicago."

UTAH SECTION—*Salt Lake City, March 8:* Joint meeting with the Utah Society of Professional Engineers and the Ogden Engineering Society. L. M. Winsor, representing the Section, spoke briefly, as did R. K. Brown for the Utah Society of Professional Engineers and O. C. Lockhart for the Ogden Engineering Society. Hack Miller then described a trip down the Salmon River with a group of explorers and explained the detailed preparations for the trip. A technicolor film depicting the journey concluded the meeting.

WISCONSIN SECTION—*Milwaukee, March 13 to 15:* Members of the Section were active on the program and committees of the Wisconsin Engineering Conference held on these dates. The luncheon on the 13th was sponsored by the Section, and on the 14th there was a technical meeting with P. W. Gamble presiding. The speakers on the latter program were O. C. Rollman, consulting civil engineer of Green Bay, Wis., and William Darby, consulting engineer of West Allis, Wis.

WYOMING SECTION—*Cheyenne, March 11:* Joint meeting with the Cheyenne Engineers Club. The feature of the evening was a paper by Philip Upp, bridge designer for the Wyoming State Highway Department, whose subject was "Small Highway Bridges, 1920–1940." Discussion of "A Program of Public Relations for Engineers in Wyoming" concluded the meeting.

Student Chapter Notes

BROOKLYN POLYTECHNIC INSTITUTE—*March 13:* Both the day and evening groups of the Student Chapter met on this date. The speaker addressing the former group was F. G. Glenz, Jr., engineering assistant for the New York City Tunnel Authority, who discussed the Queens-Mid-Town Tunnel. Later the members visited the project. The evening students heard Charles S. Gleim, engineer of construction for the Port of New York Authority, give an illustrated lecture on construction problems pertaining to the Lincoln Tunnel. Considerable discussion followed. *April 9:* Jacob Katz, traffic engineer for the New York Police Department, discussed "The Fundamentals of Traffic Control."

COLLEGE OF THE CITY OF NEW YORK—*March 7 and 14:* The Chapter was host to the student branch of the American Society of Mechanical Engineers at the first of these sessions, the speaker being Rear-Admiral R. E. Bakenhus. Admiral Bakenhus discussed "Shipyard Maintenance and Drydock Construction." The meeting on the 14th was devoted entirely to business discussion. *April 4:* Frank H. Nowaczek, assistant engineer for the New York City Board of Water Supply, gave an illustrated lecture on the Delaware water supply project.

COOPER UNION—*February 25 and March 11:* Both meetings were devoted to the presentation of student papers. At the first the speaker was George Kent, evening session student and assistant engineer for the Interborough Rapid Transit Company, whose subject was "An Intersection Problem in Trusses." Students Joseph Fegan and William Stone presented papers on "Geology and Engineering" at the March meeting.

NEW YORK UNIVERSITY—*February 28:* Members of the evening division of the Student Chapter heard an illustrated talk on the Catskill water supply system. This was given by Fergus D. O'Connell, a member of the Chapter.

NEWARK COLLEGE OF ENGINEERING—*April 1:* A talk on the East River Drive (New York) was the feature of the occasion, the speaker being Dean G. Edwards, consulting engineer for the Borough of Manhattan.

WASHINGTON STATE COLLEGE—*February 29:* "Sales Engineering for Civil Engineers" was the subject of a talk given by E. L. Haines, of the Howard Cooper Corporation of Spokane.

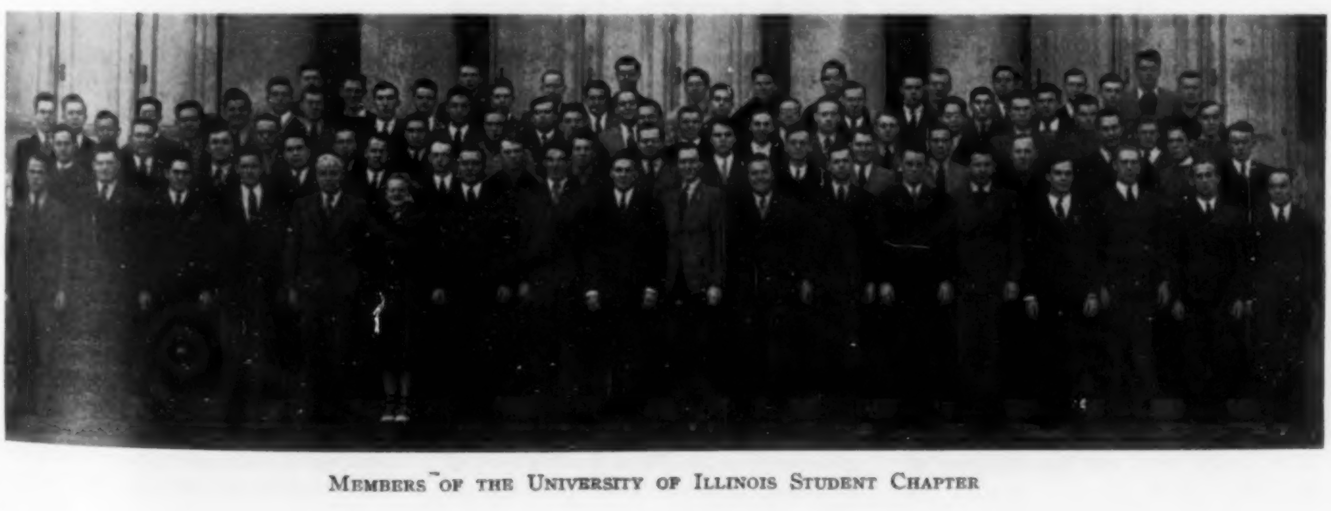
LOUISIANA STATE UNIVERSITY: Members of the Student Chapter at Louisiana State University recently visited the new Charity Hospital Building in New Orleans. George P. Rice, consulting engineer of New Orleans, conducted the group through the building, explaining the foundation settlement that has taken place and the reinforcement of the structural frame now under way.

MEMBERS OF THE LOUISIANA STATE UNIVERSITY STUDENT CHAPTER ON INSPECTION TRIP

NORTHEASTERN UNIVERSITY—*March 15:* The first meeting of the newly established Student Chapter at Northeastern University took place at this time. Delegates were present from a number of the Student Chapters in New England, and Daniel Coonan, president of the Rhode Island State College Chapter, was in charge of the inauguration exercises. Following a dinner, William C. White, assistant dean of engineering at Northeastern University, extended greetings from the university. The other speakers were Louis G. Reiniger, newly elected president of the Chapter; Andrew H. Holt, head of the department of civil engineering at Worcester Polytechnic Institute; Charles W. Banks, president of the Northeastern Section; Herman G. Protze, Jr., president of the Junior Association of the Northeastern Section; Francis H. Kingsbury, secretary-treasurer of the Northeastern Section; and Miles N. Clair, contact member for the Northeastern Chapter.

PENNSYLVANIA STATE COLLEGE—*March 4:* F. T. Mavis, head of the department of civil engineering at the college, addressed the group on the subject of "Harnessing Rivers in Miniature," in which he discussed hydraulic research problems. *March 18:* Three flood control projects proposed for the Susquehanna River were described by H. G. Douglas, captain, Corps of Engineers, U.S. Army.

UNIVERSITY OF ILLINOIS: New construction projects being erected on the campus of the University of Illinois have provided an opportunity for the Student Chapter members to study construction work in its different stages without going far afield. The structures recently inspected include two buildings and a power plant. Members of the teaching staff and contractors on the projects have accompanied the group and answered their questions.



MEMBERS OF THE UNIVERSITY OF ILLINOIS STUDENT CHAPTER

ITEMS OF INTEREST

About Engineers and Engineering

Civil Engineering for June

Hiwassee Dam, like Norris, is a storage structure on an upper tributary of the Tennessee. Cecil E. Pearce, Assoc. M. Am. Soc. C.E., will describe in the June number some of the primary factors of its design. No cutoff trench was used but the foundation drainage and grouting received special attention. A number of interesting hydraulic problems concerning the spillway and sluices are also summarized. A companion article on details solved in the planning of this structure is scheduled for a later issue.

Also in the June issue will be an article on the Navy's interest in the Port of New York—the third in the series on different phases of the development of that port. In this article, Rear Admiral Ralph W. Whitman, M. Am. Soc. C.E., will discuss the functions of the Navy's shore facilities in general and those of the Brooklyn and adjacent naval plants in particular. The article applies specifically to the Port of New York, but the basic considerations it sets forth so clearly also apply to any port.

A third paper scheduled for June is entitled "The Engineer and the Budget," by George R. Thompson, M. Am. Soc. C.E. "At first glance," says the author, "the subject of 'The Engineer and the Budget' suggests the engineer versus the budget, in the sense that as a requesting agency the engineer has his troubles with budgets," although "he does not have much trouble keeping within budgets, except perhaps his personal one." He then goes on to analyze public budgets for governmental units and to show why the engineer is well fitted by training and aptitude both to prepare them and to carry them out.

There will of course be a number of other papers on a variety of subjects of interest to civil engineers.

Brief Notes from Here and There

During the past month the American Society of Mechanical Engineers celebrated the sixtieth anniversary of its founding. It was on April 7, 1880, that eighty mechanical engineers met in the assembly room of Stevens Institute of Technology, in Hoboken, N.J., to organize their Society. They elected Robert Henry Thurston, pioneer educator in mechanical engineering as their first president. Since then the initial membership of 189 has grown to 15,000.

* * * *

The Thirty-Second Semi-Annual Meeting of the American Institute of Chemical Engineers is to be held in Buffalo, N.Y., May 13–15, 1940, with headquarters at the Statler Hotel.

Training for Civil Engineering Students

A New Course Advocated and Discussed

A Proposed Curriculum

By B. F. Hastings, M. Am. Soc. C.E.

District Engineer, American Institute of Steel Construction, Inc., Philadelphia, Pa.

There has always been a great deal of discussion concerning what constitutes an education. In more recent years, as life has become much more complex and the ways in which an individual can make his daily bread have multiplied, education has likewise become more complicated. For about a century, institutions of higher learning have attempted to develop an educational curriculum to take care of the individual with a scientific or technical bent. In recent years, the curriculum for this type of education has been much debated, and there is at present a tendency for changes which the writer, from thirty years of varied experience and contacts in technical and commercial fields, believes to be deleterious to the end that should be achieved.

In considering a technical training, the four years of preparation which the average prospective student receives in a public high school should very strongly come under scrutiny. It is absolutely wrong that educators in public schools and those in higher institutions should feel their work has no relationship to one another's. So many boys now go from the public high schools to college that some consideration should be given to them in the high school courses. Furthermore, the basic four-year high school course proposed as a preparation for future scientific and technical students also constitutes an excellent training for the average boy who may be going to work in a technical and business world at the end of his high school training.

I have always been sympathetic to the idea that an intelligent human being should have relatively wide interests in so-called cultural subjects, but I believe that a great deal of this type of training can be obtained after a formal education is finished. In addition, the requirements of a scientific or technical training have become so complex that the purely technical work to be covered in the four years of high school and the four years of undergraduate college has materially increased in recent years.

Foreign or ancient languages in particular are unnecessary and not very useful requirements for the average cultured citizen of the United States in professional or business fields. The time required for their study can well be devoted to other subjects.

The following outline for the basic requirements to be obtained in high school and the basic subjects to be taught in an engineering school presents my specific ideas. The intent of the courses is to give a training that will afford the graduate some latitude in the selection of work in professional or business or industrial fields, and commit him less to a groove than the majority of the courses now in effect. Further types of specialized training have been left to industrial organizations, where they belong, or for graduate study.

High School Preparation

English Literature	4 years
History of English Literature	½ year
General History	2 years
American Government and Problems of Democracy	1 year
American History	1 year
Bookkeeping	2 years
Physics	1 year
Chemistry	1 year
Mathematics	4 years

Courses in Engineering Schools

First Year

First and Second Terms

Calculus
Chemistry
Physics
Economics
Engineering Drawing, Descriptive Geometry, and Mechanisms

Second Year

First Term	Second Term
Advanced Calculus	Advanced Calculus
Mechanics	Mechanics of Materials
Electricity	Electrical Engineering
Finance	Hydraulics
Surveying	Option

Third Year

First Term	Second Term
Commercial Law	Framed Structures
Framed Structures	Reinforced Concrete
Power Engineering and Power Plants	Industrial Engineering
Industrial Engineering and Organization	Employment Problems
	Option

Fourth Year

Both Terms

Options in Civil, Electrical, Mechanical Engineering or Commerce and Industry
Papers and Reports

Comments on Proposed Curriculum

By Samuel B. Morris, M. Am. Soc. C.E.

Chairman of the Society's Committee on Engineering Education

I have been interested in reading Mr. Hastings' proposal. It combines high school preparation and a four-year engineering school curriculum in which the first three years are the same for all branches of engineering, thus withholding any specialization until the fourth year.

His program of high school preparation apparently includes analytical geometry, enabling students to begin the calculus in the first semester of their freshmen year. Two years of bookkeeping are included, with sacrifice, by complete absence, of English composition, foreign language, biology, art, and drafting. With the exception of drafting, none of these subjects is included in either high school or college. It would be very difficult or impossible to secure a mutual acceptance of such a program by either high schools or engineering schools.

There is nothing new in the argument that the "so-called cultural subjects" may be pursued after a formal education has been finished. There are already plenty of prominent engineering colleges following this precept in order to crowd an increasing amount of technical subjects into their four-year curricula. However, the sight of a young engineer in a construction camp laying aside his field books to study Keats after the day's work is done is still something to write home about. Fortunately students may now elect which of these two types of engineering education they prefer.

Stressing mathematics, physical sciences, and the common core of engineering fundamentals before specializing in any branch of engineering has much merit and is practiced in a number of engineering schools. However, the specific curriculum suggested allows but one semester for mechanics and does not include thermodynamics. Probably two semesters of framed structures and one of reinforced concrete constitutes more structural engineering than may reasonably be required, let us say, of cummunication engineers. Even though courses common to all engineering fields may properly fill three of the four undergraduate years, it is usually better to spread these over four years to permit a greater sequence in special fields. As an example, a student in sanitary engineering should take more chemistry and biology before the fourth year.

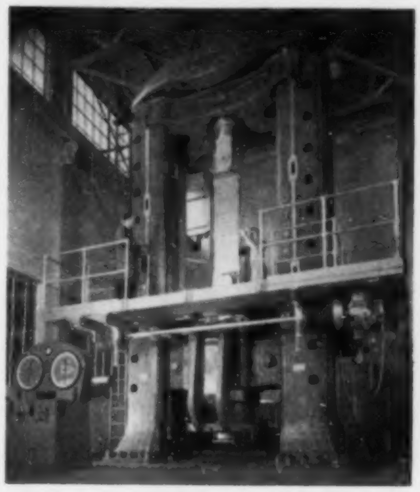
As regards Mr. Hastings' complete proposal, it should not be regarded as an ideal curricula, nor should there be any effort to establish a common curricula in all high schools and engineering colleges

Precision Testing Machine on Page of Special Interest

A CLOSE-UP view of the mechanism which operates the new three-story hydraulic monster which was installed recently in the Aluminum Research Laboratories, New Kensington, Pa., is shown on this month's "Page of Special Interest."

This machine was developed for testing full-size objects rather than mere scale models. It is capable of exerting a force of 3,000,000 lb in compression and 1,000,000 lb in tension and yet its precise control will allow the breaking of the crystal of a watch without damaging its works or the cracking of an egg without spilling its contents. While this machine is not the largest of its kind in the world, it is the "most powerful," for it can exert its maximum forces at a head speed of 36 in. per minute.

The overall height of the machine is 40 ft 4 in., of which 25 ft is above the floor



STRUCTURAL TEST UNDER WAY ON NEW TEMPLIN TESTING MACHINE

line. It is 16 ft 4 in. wide and 9 ft from front to back. The machine is called the Templin precision metal-working machine, after R. L. Templin, M. Am. Soc. C.E., chief engineer of tests for the Aluminum Company of America.

Two Memorials to Frank E. Winsor

THE LIFE work and reputation of the late Frank E. Winsor, formerly Vice-President of the Society, is to be perpetuated as a result of two activities now going forward. In Boston, a joint committee of the Boston Society of Civil Engineers and the Northeastern Section of the Society has been set up for the purpose of establishing a suitable Frank E. Winsor Memorial. It is proposed that this shall be placed at a picturesque site overlooking Winsor Dam, named in honor of Mr. Winsor. This is the chief structure for the Quabbin Reservoir, the large source of water supply in the new Metropolitan system for Boston. Since its inception and until his death a year ago, Mr. Winsor was chief engineer of this great work. Members of the joint committee are all members of the Society, as follows: Frank A. Barbour, Harrison P. Eddy, Samuel M. Ellsworth, Gordon M. Fair, Frederic H. Fay, Frank M. Gunby, Karl R. Kennison, Arthur D. Weston, Robert Spurr Weston.

According to preliminary estimates, it was felt that $2,500 was necessary for a memorial. At the latest accounting, over 90% of this amount had been contributed. Accordingly, a subcommittee consisting of Messrs. Weston, Kennison, and Ellsworth, is making the necessary arrangements for the design and placing of the memorial, in cooperation with the landscape architect and the Metropolitan District Water Supply Commission. It is expected that the work will be completed and ready for dedication within a few months.

A second tribute to Mr. Winsor takes the form of a $5,000 scholarship fund presented to Brown University by Mrs. Winsor. Under the terms of this gift, the award of the yearly scholarship is to go preferably to engineering students. This generous gift is particularly significant, not only as characteristic of Mr. Winsor's pride in his alma mater, of which he was also a trustee, but particularly as symbolic of his great interest in engineering education and in all that pertained to young engineers.

These two memorials will long serve as reminders of the accomplishments of Frank E. Winsor and the ideals that he labored so faithfully to exemplify.

NEWS OF ENGINEERS

Personal Items About Society Members

ROBERT L. E. WARD has been transferred from the U.S. Engineer Office at Sacramento, Calif., to the office at Bonneville, Ore.

JAMES E. GODFREY, formerly detailer for Madigan-Hyland in Long Island City, N.Y., has become an engineering assistant in the New York City Board of Water Supply.

B. F. WILLIAMS has resigned as project engineer for the Public Works Administration at Raymondville, Tex., to accept an appointment as technical adviser to the International Boundary Commission, with headquarters at El Paso, Tex.

JOSEPH F. HUGHES, who is with Ebasco Services, Inc., is being transferred from a project at Fort Lauderdale, Fla., to Shanghai, China, where he will assume the duties of resident engineer on the construction of an extension to the Riverside Steam Electric Station of the Shanghai Power Company.

WILLIAM H. CULLIMORE, 3d, recently resigned as associate engineer in the Baltimore (Md.) Department of Public Works to accept an appointment as engineer and secretary of the National Paving Brick Association, in Washington, D.C.

L. H. GARDNER has succeeded C. W. PFEIFFER as manager of the Philadelphia branch of the Culvert Division of the Republic Steel Corporation. He was formerly district engineer for the organization in Philadelphia. Mr. Pfeiffer has been made assistant manager of the Culvert Division and has been transferred to the general office of the Division at Canton, Ohio.

CHARLES H. MITCHELL, dean of the faculty of applied science and engineering at the University of Toronto, has been made director of Canada Steamship Lines, Ltd.

HOWARD E. SMITH has retired from the position of district engineer in the New York State Department of Public Works after more than thirty years of state service.

WILLIAM I. BROWN is now a lieutenant in the Civil Engineer Corps of the U.S. Naval Reserve, stationed at the U.S. Naval Training Station at Newport, R.I. He was previously assistant engineer for the U.S. Bureau of Reclamation at Denver, Colo.

JAMES T. PARDEE, chairman of the Board and vice-president of the Dow Chemical Company at Midland, Mich., was awarded the honorary degree of doctor of commercial science by Case School of Applied Science at its sixtieth anniversary Founders' Day Convocation, held on March 14. The degree was awarded "in recognition of his leadership and example as a pioneer in the creation of a great industry and in guiding its fiscal operations with high integrity."

SVEN SJODAHL is now with the Central Engineering Company at Moncks Corner, S.C.

CLIFFORD L. WADE, regional labor adviser for the PWA, has been transferred from Omaha, Nebr., to Chicago, Ill.

S. CLAY BAKER, until recently resident engineer on the St. Louis Municipal Bridge track improvement, is now vice-president of Continental Aerial Surveys at St. Louis, Mo.

STANLEY H. WRIGHT, formerly regional engineer and principal engineer for the Public Works Administration at Atlanta, Ga., has been assigned to the National Resources Planning Board as coordinator for the Southeastern Florida Joint Investigation. His headquarters are in the Comeau Building, West Palm Beach, Fla.

GEORGE S. RICHARDSON, consulting engineer of Pittsburgh, has been appointed a member of the Pennsylvania State Registration Board for Professional Engineers.

E. H. SCHNEIDER is now in charge of all operations for the Yampa Valley Irrigation District in central Colorado. His work will include supervision of the construction of a large earth-fill dam and hydraulic appurtenances.

ALBERT S. HIBBS, division engineer for the city of Toledo on the Lake Erie water project, has been made manager of the Chillicothe (Ohio) municipal water works to supervise construction of a water-softening plant for that city. JESSE K. GIESEY, until recently resident engineer for Greeley and Hansen at Buffalo, N.Y., has succeeded Mr. Hibbs as division engineer.

CHARLES H. BEAL has been appointed district manager and director of operations at Norfolk, Nebr., for District 1 of the WPA.

IVAN C. CRAWFORD, since 1937 dean of the school of engineering and architecture at the University of Kansas, has been appointed dean of the college of engineering at the University of Michigan. The appointment will be effective July 1. Before going to the University of Kansas Dean Crawford served for fourteen years in a similar capacity at the University of Idaho.

ARTHUR W. DEAN announces that he will carry on a consulting engineering practice jointly with LEWIS E. MOORE at 73 Tremont Street, Boston, Mass. The firm will specialize in highways, bridges, and other structures, reports, estimates, and general planning. On March 28 several hundred engineers, public officials, and friends of Mr. Dean tendered him a testimonial dinner upon the occasion of his retirement as chief engineer of the Massachusetts State Planning Board after a career of more than forty years in active public service.

T. W. RAGSDALE, principal engineer with the U.S. Engineer Department at Fort Peck, Mont., has been transferred to Portland, Ore., where he will assume similar duties in the U.S. Engineer Office of that city.

STANLEY LEVITT has resigned his position with the bridge department of the Louisiana State Highway Commission to enter upon duties with the War Department as a junior engineer in the structural design section of the 2d District of the U.S. Engineer Office at New Orleans, La.

OLE SINGSTAD, chief engineer of the New York City Tunnel Authority, was decorated on April 8 as Knight, First Class, of the Order of St. Olav, by direction of King Haakon VII of Norway. The ceremony, which took place at the office of the Authority in New York City, was conducted by Wilhelm Munthe Morgenstierne, Norwegian Minister to the United States, with the assistance of Rolf A. Christenson, Norwegian Consul General. The decoration was "in recognition of Mr. Singstad's engineering accomplishments and his contribution to Norwegian interests in New York."

T. KENNARD THOMSON, consulting engineer of New York City, was recently awarded a gold medal by the Canadian Club in recognition of his being its oldest living past-president. In 1935 honorary life membership in the Club was conferred on Dr. Thomson.

F. E. GIESECKE, director of the Texas Engineering Experiment Station of the Agricultural and Mechanical College of Texas, was recently elected president of the American Association of Heating and Ventilating Engineers.

CLOVIS J. HARKRIDER, formerly engineer examiner for the PWA, has been appointed resident zoning engineer for Fort Worth, Tex.

PAUL L. HOLLAND, chief engineer of the Public Service Commission of Maryland, has been appointed a member of the legislative committee of the Maryland Traffic Safety Committee to prepare safety bills for introduction in the general assembly.

DECEASED

CARL LINCOLN BANNISTER (Assoc. M. '05) retired engineer of Bergen, N.Y., died recently at the age of 74. From 1899 to 1904 Mr. Bannister was with the Corps of Engineers, U.S. Army, on river and harbor work. In the latter year he entered the New York State Engineer Department, where he was engaged in preparing plans and estimates for the proposed Barge Canal. After the completion of the canal Mr. Bannister was, for many years, in the Canal Engineer's Office at Syracuse, N.Y. He retired in 1933.

J. GEORGE BLOOM (M. '06) of Pasadena, Calif., died in that city on March 28, 1940, as the result of a fall. He was 72. Mr. Bloom spent a number of years in railroad work, having been with the Baltimore and Ohio from 1892 to 1903 and with the Chicago, Rock Island and Pacific Railway Company from 1903 to 1909 and, again, from 1913 until his retirement in 1929. During these years he served in a variety of capacities—as assistant engineer, district engineer, division engineer, and engineer of maintenance of way.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

FREDERICK LOUD CRANFORD (M. '21) for more than thirty years president of Frederick L. Cranford, Inc., of Brooklyn, N.Y., died at his home in that city on March 29, 1940. He was 71. Mr. Cranford's company built several sections of each of the present New York subway systems, and he himself was an early leader in the fight for transit unification. Outstanding in the civic and engineering development of Brooklyn, Mr. Cranford served as chairman of the Long Island Ten-Year Plan Committee. During the war he was appointed an assistant director of the United States nitrate plants and was in charge of construction

ANDREW H. GREEN (Assoc. M. '01) of Canefield, Dominica, B.W.I., died on December 29, 1939, at the age of 70. Mr. Green spent much of his life in the British West Indies, having gone there over thirty years ago. Earlier in his career he was engaged in work for the Chicago World's Fair, and from 1896 to 1901 directed operations of the Green Dredging Company on Lake Michigan. Later he was assistant engineer for the Chicago, Milwaukee and St. Paul Railway.

JAMES CLARK IRWIN (M. '00) of Boston, Mass., died in Newtonville, Mass., on March 20, 1940, at the age of 71. Mr. Irwin was with the New York Central Lines from 1892 until his retirement in 1938. During this long period he served in numerous capacities, including that of resident engineer on the construction of the Grand Central Terminal in New York. Later he was chief engineer of the Rutland Railroad (of the New York Central Lines), and from 1914 until his retirement he was valuation engineer for the Boston and Albany Railroad.

JAY DEWITT MOORE (Assoc. M. '23) of Sandpoint, Idaho, died on March 26, 1940, at the age of 58. Major Moore gained his early engineering experience in the U.S. Reclamation Service, being employed for a considerable period on the Belle Fourche Irrigation Project in South Dakota. He also worked for several years on the construction of Wilson Dam at Muscle Shoals and, later, was engaged in road-building work in Haiti and in construction of harbor improvements in Colombia and other South American countries. Major Moore saw service in both the Spanish-American and the World Wars and, in 1930, was commissioned a major in the Reserve Corps.

WALTER SWAIN NICHOLS (M. '13) of Philadelphia, Pa., died on March 10, 1940, at the age of 70. Mr. Nichols' early career included experience with the Norfolk and Western Railroad, the Pennsylvania Railroad, and Ford, Bacon and Davis, of New York. Later he established a consulting practice in Philadelphia, specializing in topographical and boundary surveys.

VICTOR SMITH PERSONS (Assoc. M. '17) president of the Persons Company, San Francisco, Calif., died in Sausalito, Calif., on March 5, 1940, at the age of 61. Mr. Persons' first engineering work was on the construction of the Mississippi River bridge at Thebes, Ill. In 1912 he was employed as engineer by the L. A. Norris Company, of San Francisco, and later by the J. G. White Engineering Corporation, of San Francisco. He returned to the Norris firm in 1916, and the Persons Company was organized a few years later.

WALTER EVANS SPEAR (M. '09) chief engineer of the New York City Board of Water Supply, died in New York on March 29, 1940, at the age of 65. From 1900 to 1906 Mr. Spear was principal assistant on water supply work for the late John R. Freeman. He then became connected with the Board of Water Supply, and in 1910 was put in charge of construction of the portions of the Catskill Aqueduct within the New York City limits.

WALTER E. SPEAR

After service in the war as major in the Quartermaster's Corps, he represented Ford, Bacon and Davis in Greece, where he made surveys for water supply and sewerage systems for the cities of Athens and Piraeus. Mr. Spear then (1921) resumed his duties with the Board of Water Supply, becoming acting chief engineer in 1933 and chief engineer in 1936.

EMBERT HIRAM SPRAGUE (M. '28) professor of sanitary engineering at the University of Maine, died suddenly in Bangor, Me., on March 9, 1940. Professor Sprague, who was 64, had been a member of the faculty at the University since 1915. In 1920 he was appointed to a full professorship. Before entering the teaching field he was engaged in mining, railroad, and erection work in South Africa and, for three years, was location engineer for Post and McCord, of New York City.

GUSTAV ADOLPH TRETTER (M. '04) retired vice-president of the Virginia Bridge and Iron Company, Roanoke, Va., died recently in that city at the age of 80. Born in Alsace-Lorraine, Mr. Tretter came to this country in 1890 and entered the employ of the Phoenix Bridge Company at Phoenixville, Pa. In 1908 he became connected with the Virginia Bridge and Iron Company as erection manager and, later, was made vice-president in charge of engineering and erection. He retired from active service in 1929.

PETER VON WEYMARN (M. '33) hydroelectric engineer for the Federal Power Commission, Chicago, Ill., died in that city on February 12, 1940, at the age of 58. A native of Finland, Mr. von Weymarn was in the engineering service of the Imperial Russian Government from 1907 to 1918. He was then in the service of the British and Armenian governments, coming to this country in the early twenties. From 1925 to 1929 he was office engineer for the Sewane Corporation at Hewlett, N.Y., and from 1930 to 1932 he was in the U.S. War Department. In the latter year he became connected with the Federal Power Commission.

MAURICE MAYER WYCKOFF (Assoc. M. '18) engineer-attorney (Wyckoff Engineering Corporation), New York City, died suddenly in Brooklyn, N.Y., on March 9, 1940. He was 47. Early in his career Mr. Wyckoff was employed, successively, by the Alabama Power Company, the Interstate Commerce Commission, and the T. A. Gillespie Company, of Boston, Mass. Later he studied law and, in 1928, became associated with Maxwell Wyckoff in the law firm of Wyckoff and Wyckoff, to specialize in legal matters pertaining to engineering.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From March 10 to April 9, 1940, Inclusive

ADDITIONS TO MEMBERSHIP

ADCOCK, ANDREW JACKSON (Assoc. M. '40), Senior Res. Engr., State Highway Dept., Box 253, Van Horn, Tex.

AXELSON, EDWARD WILLIAM (Jun. '39), Cadet Engr., Minneapolis Gas Light Co., 8th and Marquette, Minneapolis, Minn.

BASKIN, BENJAMIN (Jun. '39), Sub Insp., U.S. Engr. Office, 3d and Broadway, Little Rock, Ark.

BECKHAM, WILLIAM KINSLER (M. '40), Maintenance Engr., State Highway Dept. (Res., 508 Saluda Ave.), Columbia, S.C.

BELL, DAVID ARTHUR (Jun. '39), Supt., Constr., WPA, Baton Rouge (Res., 1810 Madison St., Lake Charles), La.

BERRIGAN, PAUL DUNN (Assoc. M. '40), Capt., Corps of Engrs., U.S. Army, 628 Pittock Blk., Portland, Ore.

BITTNER, SAMUEL EDGAR, JR. (Assoc. M. '40), Associate Engr., U.S. Engr. Corps, Tionesta Dam, Tionesta, Pa.

BONDURANT, DONALD CONNALLY (Assoc. M. '40), Asst. Engr., U.S. Engr. Office, Caddoa, Colo.

TOTAL MEMBERSHIP AS OF APRIL 9, 1940

Members	5,620
Associate Members	6,402
Corporate Members	12,022
Honorary Members	31
Juniors	4,199
Affiliates	70
Fellows	1
Total	16,323

[Editor's Note: In the April issue the membership total was incorrectly stated as 18,245 instead of 16,245.]

BOON, LEONARD FRANCIS (Assoc. M. '40), Asst Prof., Civ. Eng., Univ. of Minnesota, Minneapolis, Minn.

BRENMAN, HARRY (Jun. '39), with Lackawanna Steel Constr. Corp., Broadway and Walden, Buffalo (Res., 31 St. Joseph St., Lancaster), N.Y.

BROOKS, MARVIN VANCIL (Jun. '39), Junior Hydr. Engr., U.S. Geological Survey, Room 300 State Highway Bldg., Austin, Tex.

BUCHHOLZ, FRANK JOSEPH (Jun. '39), Junior Engr., SCS, Lander, Wyo.

BURKART, WILLIAM FRANCIS (Jun. '39), Instr., Rational and Technical Mechanics, Rensselaer Polytechnic Inst. (Res., 1908 Seventh Ave.), Troy, N.Y.

CASTER, ARTHUR DAWSON (Jun. '40), Supt., New Castle Sewage Treatment Works, Greensboro Rd. (Res., 1537 A Ave.), New Castle, Ind.

CERUTTI, EUGENE JOHN (Jun. '39), Plainfield, Vt.

CHENG, TA TUNG (Jun. '39), Asst. Engr., Eng. Dept., Central Office, Yunnan Burma Ry., Lufeng, Yunnan, China.

CLAVAN, BERNARD PAUL (Jun. '39), Draftsman, Anchor Hocking Glass Corp., Salem, N.J. (Res., 6124 Carpenter St., Philadelphia, Pa.)

CLEAR, FREDERICK ANTHONY (Jun. '40), Constr. Engr., The Austin Co., 19 Rector St. (Res., 575 West 159th St.), New York, N.Y.

CONNOR, EDWARD COWEN (M. '40), Cons. Engr., 1915 Wood St., Dallas, Tex.

CONSOLI, JOSEPH JOHN (Jun. '39), Chairman, Pennsylvania Turnpike Comm., Mount Pleasant (Res., 520 Waddell Ave., Clairton), Pa.

COUSAR, HUGH CHARLTON, JR. (Jun. '40), Junior Engr., U.S. Engr. Dept., U.S. Engr. Office (Res., 1108 Government St.), Mobile, Ala.

CURRY, THOMAS SHERROD, JR. (Jun. '40), Draftsman, International Boundary Comm., United States and Mexico, 627 First National Bank (Res., 3413 Nashville St.), El Paso, Tex.

DANIELS, WARREN SIDNEY (Jun. '40), Junior Hydr. Engr., U.S. Geological Survey, Box 3877, University, La.

DAVIS, SAMUEL (Jun. '39), Production Clerk, Noorduyn Aviation, Ltd., 1411 Crescent St. (Res., Central Y. M. C. A.), Montreal, Que., Canada.

DOMORSKI, BRUCE PAUL (Jun. '39), Building Contr., 60 Forest Hill Rd., West Orange, N.J.

DUNSING, WILLIAM JOSEPH (M. '40), Asst. Engr., Office, Borough Pres. of Queens, Topographical Bureau, 4522 Court Sq., Long Island City (Res., 8732 Seventy-Fifth St., Woodhaven), N.Y.

EATON, WILLIAM ROBERT (Assoc. M. '39), Associate Hydr. Engr., U.S. Geological Survey, 442 Post Office Bldg., Chattanooga, Tenn.

EINSTEIN, HANS ALBERT (Assoc. M. '40), Hydr. Engr., SCS, U.S. Dept. of Agriculture, Box 1558 (Res., 10 Randall Court Apartments), Greenville, S.C.

EISNER, BENJAMIN (M. '40), Chf. Engr., Clay Sewer Pipe Assoc., Inc., 945 Oliver Bldg., Pittsburgh, Pa.

EVANS, ROBERT BAUR (Jun. '39), 1 Birchwood Rd., Glen Rock, N.J.

FOX, RICHARD BURKHOLDER (Assoc. M. '40), Graduate Asst., Architectural Eng., Pennsylvania State Coll., 526 West Nittany Ave., State College, Pa.

GOLDHAMMER, SIDNEY INGRAM (Jun. '39), Eng. Draftsman, Tax Surveyor's Office, City Hall (Res., 86 Bloomfield Ave.), Newark, N.J.

GREENE, JOSEPH JOHN (M. '39), Cons. Engr., Scottish House, 90 William St., Melbourne, Australia.

GRISWOLD, EDGAR ALLEN (Jun. '39), Junior Engr., War Dept., 751 South Figueroa St. (Res., 6641 Pollard St.), Los Angeles, Calif.

GUERNSEY, ROSCOE, JR. (Jun. '40), 106 Oak Tree Pl., Leonia, N.J.

HARRINGTON, EDWIN LINCOLN (Assoc. M. '40), Instr., Dept. Civ. Eng., Agri. and Mech. Coll. of Texas, College Station, Tex.

HAUGE, LESTER NORMAN (Jun. '39), Engr., Gravity Meter Crew (Geophysical), Magnolia Petroleum Co., Dallas (Res., 504 North 19th St., Corsicana), Tex.

HEYDT, FREDERICK GEORGE (Assoc. M. '40), Pres., Heydt-Mugler Co., Inc., Longfellow and Viele Ave. (Res., 4440 Waldo Ave.), New York, N.Y.

HICKS, HERBERT SCOBLE (M. '40), Engr., Jerome A. Utley, Box 6, North End Station (Res., 14610 Westwood), Detroit, Mich.

HOLBROOK, CHARLES MARSH (Jun. '39), Draftsman, Fay, Spofford & Thorndike, 11 Beacon St., Boston (Res., 15 Freeman St., Arlington), Mass.

HOROWITZ, HARRY NATHAN (Jun. '40), Insp., Gen. Constr., U.S. Bureau of Reclamation (Res., 2 Hagman Apartments), Leavenworth, Wash.

HUBER, CHARLES EDWARD (Assoc. M. '40), Associate Engr., U.S. Engr. Office, 332 Post Office Bldg., Baltimore, Md.

HUBLER, JOHN WILLIAM (Assoc. M. '40), Instr., Purdue Univ., Old Agri. Eng. Bldg., Lafayette, Ind.

HUDDLESTON, PAUL MCKISSON (Jun. '39), Civ. Engr., John F. Reynolds, 316 Duval Bldg., Jacksonville, Fla.

HULICK, DAN (Assoc. M. '40), San. Engr., USHA, 5th St. and New York Ave., N.W., Washington, D.C. (Res., Gladstone, N.J.)

HUME, WILLIAM, II (Assoc. M. '40), Asst. Prof., Civ. Eng., Univ. of New Mexico, Albuquerque, N.Mex.

INABA, MINORU (Assoc. M. '40), Designer, Parsons, Klapp, Brinckerhoff & Douglas, 142 Maiden Lane (Res., 75 Wadsworth Terrace), New York, N.Y.

JACKSON, GEORGE ROBERT (Jun. '39), Draftsman, Boeing Airplane Co. (Res., 4730 Nineteenth, N.E.), Seattle, Wash.

KASSNER, JOHN JACOB (Assoc. M. '40), Topographical Draftsman, Grade 4, City of New York, Office, Borough Pres. of Manhattan, Dept. of Borough Works, Room 2122 Municipal Bldg., New York (Res., 800 Ave. H, Brooklyn), N.Y.

KEMPTON, JOHN PARKER (Jun. '39), Care, Public Roads Administration, Room 426 Federal Office Bldg., San Francisco, Calif.

KNUDSON, KENNETH IRVING CHARLES (Jun. '39), Architectural Engr., Northwestern Mutual Life Insurance Co., Wisconsin Ave. (Res., 1523 Alice St.), Milwaukee, Wis.

LIUM, ELDER LEONARD (M. '40), Associate Prof. and Head, Civ. Eng. Dept., Univ. of North Dakota (Res., 921 Reeves Drive), Grand Forks, N.Dak.

LOUCKS, DONALD ALLEN (Assoc. M. '40), 3513 Olive Ave., Long Beach, Calif.

McGLAUFLIN, STANLEY ALLAN (Jun. '40), Asst. Engr., U.S. Bureau of Reclamation, Customhouse, Denver, Colo.

MEDFORD, ALBERT JAY (Jun. '40), Junior Agri. Engr., SCS, (Res., 336 B North Highland), Tucson, Ariz.

MELVIN, JOHN HARPER (Assoc. M. '40), Res. Geologist, U.S. Engr. Sub Office, Mountain Home, Ark.

MOONEY, JOSEPH RICHARD (Jun. '39), Draftsman, Gulf Research & Development Co., Box 217, Morton, Miss. (Res., 3600 Dumaine St., New Orleans, La.)

MORABITO, SYLVESTER (Jun. '39), Junior Hydr. Engr., SCS, 1812 R St., N.W., Washington, D.C.

MORRIS, ROBERT DELMER (Assoc. M. '40), Asst. Engr. (Civ.), War Dept., Care, Dept. Engr., Corozal, Canal Zone.

MUELLER, HERBERT BERT (Jun. '40), Engr., Massman Constr. Co., Box 227, Langley, Okla.

PECKHAM, WARREN MONROE (Jun. '40), 718 West Washington St., Champaign, Ill.

PEEBLES, SAMUEL COLES, JR. (Jun. '39), Draftsman, Mount Vernon Bridge Co. (Res., Hotel Curtis), Mount Vernon, Ohio.

PIERCE, ROBERT ELLIOTT (M. '40), Dist. Engr., State Dept. of Public Works, Div. of Highways, 1200 North Center St., Stockton, Calif.

PORTEOUS, RONALD MILTON (Jun. '39), Asst., Pennsylvania State Coll., 316 South Allen, State College, Pa.

POSTELS, RAYMOND CHARLES (Jun. '39), Eng. Asst., D. & R. G. W. R. R., 628 Ouray Ave., Grand Junction, Colo.

QUINN, GUSTAVE GENIN (Assoc. M. '40), Co-Partner and Structural Engr. (Dunn & Quinn), Box 483, Lake Charles, La.

RAMIREZ, JOSEPH PALOS (Jun. '39), With Carnegie Illinois Steel Corporation, 3426 East 89th St. (Res., 8926 Ave. O), Chicago, Ill.

REEDER, EARL JOHN (M. '40), Chf. Traffic Engr., National Safety Council, 20 North Wacker Drive, Chicago (Res., 1000 Ridge Ave., Evanston), Ill.

ROBERTSON, JOHN MARK (Jun. '40), Graduate Research Asst., Joint Highway Research Project, Room 215 Civ. Eng. Bldg., Purdue Univ., Lafayette, Ind.

ROBINSON, CLINTON FREDERICK (M. '40), Corps of Engrs., U.S. Army, WPA, 70 Columbus Ave., New York, N.Y.

ROETTIGER, EMMONS LORENZ (M. '40), State Highway Engr., State Highway Comm., State Office Bldg. (Res., 2750 Chamberlain Ave.), Madison, Wis.

ROGERS, THOMAS WILSON (Jun. '39), With Eureka Pipe Line Co., Blue Creek (Res., Elkview), W.Va.

ROSEDALE, IRVING HARRIS (Jun. '40), Office Engr., Pacific Bridge Co., 333 Kearny St., San Francisco (Res., 1657 Tacoma Ave., Berkeley), Calif.

RUPP, VERNON WARD (Assoc. M. '40), Associate Hydrologic Engr., U.S. Weather Bureau, San Francisco, Calif.

RUSSELL, WILFORD BATES (M. '40), Chf. Engr., Peerless Cement Corporation, 1144 Free Press Bldg., Detroit, Mich.

SAWYER, HERBERT ALLEN, JR. (Jun. '40), 2794 Yale Station, New Haven, Conn.

SCHULZ, WILLIAM HAGAN (Jun. '40), Draftsman, Am. Creosoting Co., Columbia Bldg. (Res., 16 Eastover Court), Louisville, Ky.

SITEK, FRANCIS JOHN (Jun. '39), 390 Harvard St., Cambridge, Mass.

SLIGAR, JAMES NEWTON, JR. (Jun. '39), Rodman, State Highway Dept., Box 416, Fort Davis, Tex.

SMITH, HUBERT SHIRLEY (M. '39), Care, The Cleveland Bridge & Eng. Co., Ltd., Box 6735, Calcutta, India.

SPENCER, THOMAS FURMAN (Jun. '40), Junior Engr., The Panama Canal, 1435 K St., N.W. (Res., 7003 Ninth St., N.W.), Washington, D.C.

SPRING, VALENTINE FISHER (M. '40), Engr., U.S. Engr. Office, 900 Custom House (Res., 2734 South Darien St.), Philadelphia, Pa.

STARR, ALBERT RUDOLPH (Jun. '39), with Caterpillar Tractor Co. (Res., 1112 Griswold Ave.), Peoria, Ill.

STIMPSON, CLARENCE AMOS (Assoc. M. '40), Senior Engr., Jensen, Bowen & Farrell, 209 Michigan Theatre Bldg., Ann Arbor, Mich.

THOMAS, GORDON EVAN (Assoc. M. '40), Associate Materials Engr., TVA, The Kentucky Project, Gilbertsville, Ky.

THOMS, JOSEPH CHAK (Assoc. M. '40), Asst. Engr., Levitt & Sons, Inc., Northern Boulevard, Manhasset (Res., 89 Doncaster Rd., Malverne), N.Y.

THORNTON, MARVIN IRA (Jun. '39), Care, State Highway Dept., Newton, Tex.

THORNTON, ROBERT MELVIN (Jun. '39), Draftsman, Am. Blower Corp., 6000 Russell St. (Res., 9908 Belleterre Ave.), Detroit, Mich.

UFFELMAN, THOMAS NEIL, JR. (Jun. '39), Senior Foreman Engr., Dept. of Interior, National Park Service, TVA, Harrison Bay State Park P-15, Harrison (Res., 1012 Eighteenth Ave., South, Nashville), Tenn.

VAN BREDA, ANTHONY JEAN (Jun. '39), Dist. San. Engr., State Dept. of Public Health, Front and Central Sts., Gilman, Ill.

VANDERSLOOT, PETER RALPH (Jun. '40), Eng. Draftsman, Stone & Webster Eng. Corp., 49 Federal St., Boston (Res., 180 Summer St., Malden), Mass.

WILLIAMSON, HAROLD ELMER (Jun. '39), Student Engr., War Dept., U.S. Engr. Office, Federal Bldg. (Res., 1533 Ruth Ave.), Cincinnati, Ohio.

MEMBERSHIP TRANSFERS

ANSON, EDWARD HIRAM (Assoc. M. '32; M. '40), Engr., Gibbs & Hill, Inc., Room 490 Pennsylvania Station, New York, N.Y.

BLISS, PERCY HENRY (Jun. '32; Assoc. M. '40), Junior Hydr. Engr., U.S. Engrs., Gay Bldg., Little Rock, Ark.

CARTER, ISAAC NEWTON (Assoc. M. '29; M. '40), Prof., Civ. Eng., Univ. of Idaho, Moscow, Idaho.

CHENWORTH, CHARLES FRANCIS (Jun. '30; Assoc. M. '40), Aid, U.S. Coast and Geodetic Survey, Washington, D.C.

CLASSEN, ASHLEY GREEN (Jun. '27; Assoc. M. '29; M. '39), Supt. and Chf. Engr., Dept. of Water and Sewerage, City of El Paso, Box 511 (Res., 3804 Cambridge St.), El Paso, Tex.

CORBER, CHAMP ELKINS (Jun. '35; Assoc. M. '40), Bridge Designer, Washington Toll Bridge Authority, 930 Lakeside Ave., South (Res., 714 Lakeside Ave., South), Seattle, Wash.

DAVIS, ROBERT OLIN (Jun. '31; Assoc. M. '39), Asst. Topographic Engr., U.S. Geological Survey, Washington, D.C.

FAXON, ALFRED AUSTIN (Jun. '36; Assoc. M. '40), Traveling Insp., State Highway Dept., State House Annex, Trenton (Res., 213 Locust St., Moorestown), N.J.

FOWLE, ROYAL EDGAR (Jun. '30; Assoc. M. '32; M. '40), Engr. and Production Mgr., Granite Rock Co., Box 151 (Res., 74 Monte Vista Ave.), Watsonville, Calif.

GERARDI, JASPER (Jun. '36; Assoc. M. '40), Director, Eng. Drawing, Univ. of Detroit, McNichols Rd. and Livernois, Detroit, Mich.

HANKS, LAWRENCE FILLER (Jun. '30; Assoc. M. '40), Asst. Engr., U.S. Geological Survey, 230 Customhouse, Denver, Colo.

HICKS, EDGAR FLANOY, JR. (Jun. '30; Assoc. M. '40), Ensign, U.S. Coast and Geodetic Survey, 601 Federal Office Bldg., Seattle, Wash.

HILL, BRYON ARTHUR (Jun. '28; Assoc. M. '30; M. '40), Supt. of Constr., California Inst. of Technology, Care, Astrophysics Observatory, Palomar Mountain, Calif.

HOLLAND, ELWOOD WILLIAM (Jun. '34; Assoc. M. '40), Senior Office Engr., WPA, 1206 South Santee St. (Res., 5383 Somerset St.), Los Angeles, Calif.

ITANI, SALAHUDDIN (Jun. '29; Assoc. M. '39), Irrig. Engr., Irrigation Directorate, Baghdad, Iraq. (Res., 134 Rue G. Picot, Beyrouth, Syria.)

KETCHEN, ALECK PETRIE (Jun. '36; Assoc. M. '40), Asst. Engr., U.S. Bureau of Reclamation, Box 998, Emmett, Idaho.

KNOERLE, JOSEPH KARL (Assoc. M. '29; M. '40), Project Engr., The J. E. Greiner Co., 1201 St. Paul St., Baltimore, Md.

KOHL, JOHN CLAYTON (Jun. '29; Assoc. M. '40), Sales Engr., Pittsburgh Corning Corporation, Grant Bldg. (Res., 508 Cathedral Mansions, Ellsworth at Clyde St.), Pittsburgh, Pa.

LANGBEIN, WALTER BASIL (Jun. '32; Assoc. M. '40), Associate Hydr. Engr., U.S. Geological Survey, 2226 North Interior Bldg., Washington, D.C.

NETLAND, THEODORE JARL BUGGE (Jun. '32; Assoc. M. '40), Asst. Hydrographer, East Bay Municipal Utility Dist., 512 Sixteenth St., Oakland (Res., 430 South Church St., Lodi), Calif.

QUADE, CHARLES OMAR (Jun. '28; Assoc. M. '40), Office Engr., Constr. Outlet Works, U.S. Engrs., Denison, Tex.

RENN, RAYMOND WILLIAM (Jun. '26; Assoc. M. '27; M. '40), Associate Prof., Dept. of Coordination, Univ. of Cincinnati (Res., 3118 Penrose Pl., Westwood), Cincinnati, Ohio.

RHEINSTEIN, ALFRED (Jun. '12; Assoc. M. '21; M. '40), Pres., Rheinstein Constr. Co., Inc., 21 East 40th St. (Res., 42 East 71st St.), New York, N.Y.

SJOBERG, HAROLD OLIVER (Jun. '28; Assoc. M. '40), Structural Designing Engr., The Austin Co., 1945 Broadway (Res., 4041 Fruitvale Ave.), Oakland, Calif.

SMITH, PAUL ALBERT (Assoc. M. '31; M. '40), Hydrographic and Geodetic Engr., U.S. Coast and Geodetic Survey, Washington, D.C.

SNODERLY, MURPHY ULYSSES (Assoc. M. '29; M. '40), City Mgr., Municipal Bldg., Johnson City, Tenn.

SPICER, CHARLES BRYSON (Jun. '33; Assoc. M. '40), Junior Engr., U.S. Engr. Dept., Pittock Block (Res., 2430 North East 9th Ave.), Portland, Ore.

WIKSTROM, ARVE SIXTEN (Jun. '29; Assoc. M. '40), Gen. Contr. (A. S. Wikstrom), East Main St. (Res., Washington Rd.), Bound Brook, N.J.

REINSTATEMENTS

CULLIMORE, WILLIAM HENRY HARRISON, 3d, Assoc. M., reinstated Mar. 16, 1940.

GALLIGAN, WILLIAM EDWARD, Assoc. M., reinstated Mar. 25, 1940.

LOGAN, JAMES, Assoc. M., reinstated Apr. 6, 1940.

ROSEDALE, JOSEPH JACOB, Assoc. M., reinstated Mar. 30, 1940.

RESIGNATIONS

FRANK, GEORGE STEDMAN, Assoc. M., resigned Apr. 1, 1940.

GROSSO, SAMUEL JOHN, Jun., resigned Apr. 1, 1940.

KRAFT, ELMER ALEXANDER, Jun., resigned Apr. 3, 1940.

MEIHOFER, ANTHONY RUDOLPH, Jun., resigned Mar. 18, 1940.

YOUNG, KENNETH, Assoc. M., resigned Apr. 1, 1940.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment from Members to Board of Direction

May 1, 1940 NUMBER 5

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

Grade	General Requirement	Age	Length of Active Practice	Responsible Charge of Work
Member	Qualified to design as well as to direct important work	35 years	12 years	5 years RCM*
Associate Member	Qualified to direct work	27 years	8 years	1 year RCA*
Junior	Qualified for sub-professional work	20 years	4 years	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years	5 years RCM*

* In the following list RCA (responsible charge—Associate Member standard) denotes years of responsible charge of work as principal or subordinate, and RCM (responsible charge—Member standard) denotes years of responsible charge of IMPORTANT work, i. e., work of considerable magnitude or considerable complexity.

APPLYING FOR MEMBER

BUCK, HENRY WOLCOTT (Assoc. M.), Hartford, Conn. (Age 36) (Claims RCA 1.5 RCM 6.8) Jan. 1935 to Dec. 1938 Cons. Engr. and Industrial Archt., and Jan. 1939 to date member of firm, Buck & Buck.

COTTON, JOHN STERLING, San Francisco, Calif. (Age 38) (Claims RC 10.7 D 5.6) Aug. 1936 to date Senior Engr., Federal Power Comm.; previously Superv. Engr., U.S. Forest Service.

CULLIMORE, WILLIAM HENRY HARRISON, III (Assoc. M.) Washington, D.C. (Age 40) (Claims RCA 7.9 RCM 9.1) March 1940 to date Engr.-Secy., National Paving Brick Association; previously with City of Baltimore as Draftsman, Asst. Engr., Office Engr., Associate Civ. Engr. of Highways, Asst. to Highways Engr., and Associate Engr.

DAVIDSON, FREDERIC ARMSTRONG (Assoc. M.), New Rochelle, N.Y. (Age 46) (Claims RC 18.7 D 7.5) Oct. 1936 to date Engr., Coverdale & Colpitts, Cons. Engrs., New York City; previously Cons. Engr., New York City.

DEIGNAN, JOHN EUGENE (Assoc. M.), Pittsburgh, Pa. (Age 37) (Claims RC 11.2 D 5.7) Aug. 1935 to date with U.S. Engr. Office, as Asst. Engr., Associate Engr., and Engr.; previously with The Panama Canal, Madden Dam, Canal Zone as Asst. Concrete Technician and Chf. Concrete Technician.

DONOHUE, EDWARD BROWN, Helena, Mont. (Age 44) (Claims RCA 2.7 RCM 15.0) April 1937 to date Engr. and Chf. Engr., State Water Conservation Board; also, since Nov. 1938 State Engr.; previously Res. Engr., Chf. of Party, Inspector, Div. Engr., Maintenance Engr., Constr. Engr., and Asst. Chf. Engr., Montana Highway Comm.

EUBANKS, CECIL EARL, Knoxville, Tenn. (Age 38) (Claims RC 10.8 D 8.6) 1924 to 1927 and 1930 to date with Water Dept., as Draftsman, Pitometer Operator, Engr., Asst. to Engr., Asst. Supt., Owners Supervisor, at present Chf. Engr., Water Bureau.

FINCK, GEORGE EDWARD (Assoc. M.), Baltimore, Md. (Age 47) (Claims RCA 4.4 RCM 20.2) Aug. 1925 to date with City of Baltimore, Md., since Dec. 1931 as Head of Bureau of Sewers.

FOSS, FREDERIC DEARBORN, Baldwin, N.Y. (Age 45) (Claims RCA 5.7 RCM 12.5) Feb. 1940 to date Chf. Constr. Engr., M. W. Del Gaduio, Cons. Engr. for New York City Housing Authority; previously Project Supervisor, New York City Housing Authority; Constr. Mgr., Suburban National, Inc. (Hegeman-Harris Co.), and Constr. Mgr., Fred F. French Co., both of New York City.

HALE, JOHN FLOTRON (Assoc. M.), Dayton, Ohio. (Age 45) (Claims RCA 4.3 RCM 16.4) Oct. 1923 to date with City of Dayton as City Engr., Special Engr., and (since July 1936) Chf. Engr.

HASSELBACH, WILLIAM HENRY (Assoc. M.), Toledo, Ohio. (Age 38) (Claims RCA 2.0 RCM 12.6) Sept. 1929 to date with Libbey-Owens-Ford Glass Co., as Constr. Engr., and since Oct. 1937 Chf. Constr. Engr.

JELINEK, OTTO KOPP, Chicago, Ill. (Age 40) (Claims RCM 10.0) 1918 to date with old South Park Dist., after 1934 with Chicago Park Dist., successively as Rodman, Instrumentman, Inspector, Constr. Inspector, Engr. Inspector, Draftsman, Senior Draftsman, Asst. Engr. and Traffic Engr.

MACKALL, MURRAY RANDOLPH, San Francisco, Calif. (Age 49) (Claims RCA 6.0 RCM 17.5) April 1920 to date with California R. R. Comm., as Engr., Hydr. Div., and (since Jan. 1925) Hydr. Engr.; 1935 to date Examiner.

MILLER, ORRIS JOSEPH (Assoc. M.), Nashville, Tenn. (Age 48) (Claims RCA 3.4 RCM 19.0) 1920 to date with Tennessee Electric Power

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Co., Chattanooga, Tenn., as Civ. and Hydr. Engr., Production Supt., and (since 1928) Mgr., Production & Transmission.

NIKIRK, FRANK AUSTIN, Peoria, Ill. (Age 58) (Claims RCM 27.4) March 1927 to date Consultant, Caterpillar Tractor Co.

PAPPMEIER, LOUIS STAHL, Peoria, Ill. (Age 42) (Claims RCA 3.1 RCM 15.5) Oct. 1936 to date Civ. and Cons. Engr.; previously with Illinois Div. of Highways as Dist. Engr. of County Roads and of City Streets.

PNEUMAN, FRED ASHLEY, Gary, Ind. (Age 40) (Claims RCA 7.0 RCM 7.3) 1922 to date with American Bridge Co., as Draftsman, Asst. Squad Foreman, Field Engr., Res. Engr., and (since March 1939) in designing office.

PRATLEY, PHILIP LOUIS, Montreal, Que., Canada. (Age 55) (Claims RCA 1.2 RCM 28.6) April 1921 to date member of firm, Monsarrat & Pratley, Cons. Civ. Engrs.

REYBOLD, EUGENE, Little Rock, Ark. (Age 56) (Claims RCA 4.0 RCM 13.8) 1908 to date with U.S. Army as 2d Lieut., 1st Lieut, Capt., Major, Lieut.-Col., and (since 1937) Col.

RHOADES, CLIFFORD THOMAS, Augusta, Me. (Age 38) (Claims RC 11.4 D 11.6) Oct. 1939 to date Structural Engr., New England Public Service Co.; previously Structural Designer and Supervisor of Designers, New England Power Co., Boston, Mass; Structural Designer, Waghorne Brown Co.; Asst. Designer and Structural Designer, J. R. Worcester & Co.

RICKER, CONNY CLYDE, Paducah, Ky. (Age 49) (Claims RCA 9.1 RCM 16.6) Aug. to Dec. 1935 Asst. Agricultural Engr. and Dec. 1935 to date Associate Agricultural Engr., U.S. Dept. of Agriculture, Soil Conservation Service; previously with Farm Credit Administration as Land Bank Appraiser, Asst. of Chf. Appraiser and Appraiser; also, Asst. Mortgage Loan Examiner, and Special Reviewer for Land Bank Commr.

SKEAT, GEORGE WILLIAM, Chicago, Ill. (Age 44) (Claims RCA 7.5 RCM 13.0) March 1922 to April 1926 and June 1936 to date with American Bridge Co., as Checker, Asst. Squad Foreman, and (since June 1936) checking, laying out, and designing bridge work; in the interim with Strauss Eng. Corporation, and Robins Conveying Belt Co., both of Chicago, Ill.

WIESENBERG, WILLIAM MAURICE (Assoc. M.), New York City. (Age 49) (Claims RCA 4.0 RCM 20.4) May 1935 to date Res. Engr. in charge, and Associate Engr., PWA; previously Treas. and Gen. Mgr., Wilmur Eng. Co., Inc., New York City and Newark, N.J.

APPLYING FOR ASSOCIATE MEMBER

AMIDON, ROGER EDMUND, Glendora, Calif. (Age 35) (Claims RCA 8.4 RCM 3.4) March 1937 to date with U.S. Forest Service, Div. of Maps and Surveys, and Bridge Dept.; previously Jun. Engr., U.S. Geological Survey.

BEERUP, CLOYD DOUGLAS, Ames, Iowa. (Age 29) (Claims RC 4.8 D 3.7) Sept. 1938 to date at Iowa State Coll., as Instructor, and (since June 1939) Research Associate, Eng. Experiment Station; previously Chf. Engr., Tiernan Eng. Co.; Rodman, Chicago, Milwaukee, St. Paul & Pacific R.R.; Senior Engr., SCS.

BENSON, RUPERT ARTHUR, Camp Hill, Pa. (Age 36) (Claims RCA 8.3) Feb. 1939 to date Designer, Pennsylvania Turnpike Comm., Harrisburg, Pa.; previously Field Engr., Municipal Eng. Co., Pittsburgh; Chf. of Party with Alex Hutchinson, Engr., Wilkinsburg, Pa., and Carnegie Illinois Steel Co., Pittsburgh; Surveyman and Computer with U.S. Engrs., Pittsburgh; Instrumentman, Computer Draftsman, Chf. of Party and Supervisor of Survey Corps, Pennsylvania Dept. of Highways, Pittsburgh.

BOLLMAN, LESLIE WEBER (Junior), Napanoch, N.Y. (Age 31) (Claims RCA 2.0) April 1938 to date Transitman, Grade 4, New York City Board of Water Supply; previously Asst. Engr., WPA, New York City; Topographical Draftsman, New York & Queens Gas Co., Flushing N.Y.

BRINGHURST, JOHN HENRY, JR. (Junior), Greenville, S.C. (Age 27) (Claims RCA 1.6 RCM 1.2) May 1937 to date Civ. Engr., J. E. Sirrine & Co.; previously with Gulf Oil Corporation, Production Div., Civ. Eng. Dept., Houston, Tex., as Chainman, Draftsman, and Asst. Civ. Engr.

BROWN, ROGER CHIPMAN, New Haven, Conn. (Age 39) (Claims RCA 8.0 RCM 4.1) March 1930 to March 1938 with Blair and Marchant, Inc., and March 1938 to date with Clarence M. Blair, Inc.

BUCK, ROBINSON DUDLEY (Junior), Hartford, Conn. (Age 30) (Claims RCA 1.2 RCM 3.3) Oct. 1935 to Dec. 1938 Associate with Henry Wolcott Buck, and Jan. 1939 to date member of firm, Buck & Buck; previously Asst. Engr., Bureau of Public Works, Metropolitan Dist., Hartford County, Conn.

BURTON, JAMES EDWARD (Junior), Topeka, Kans. (Age 32) (Claims RCA 4.4) Dec. 1933 to date with Kansas State Highway Comm., as Instrumentman, Party Chf., and (since May 1937) Associate Engr.

CATES, VINCENT KACZYNSKI, Melrose, Mass. (Age 38) (Claims RCA 6.8 RCM 8.3) Dec. 1937 to date Tech. Service Engr., Universal Atlas Cement Co., New York City; previously owner, Vincent K. Cates Constr., Melrose, Mass.

CHRISTENSEN, JOHN JOSEPH (Junior), West New Brighton, N.Y. (Age 32) (Claims RCA 3.0) Feb. 1931 to Dec. 1932 and April 1937 to date Eng. Asst., Board of Transportation, City of New York; in the interim with CWA as Supt. of Constr. and Asst. Engr.

COAKLEY, EDWARD ALBERT (Junior), Jamaica Estates, N.Y. (Age 32) (Claims RCA 4.2) April 1938 to date with FHA, examining, and consulting with architects, engineers and contractors; previously with Mortgage Comm. Servicing Corporation.

CREED, JOHN HEDLEY, Ukiah, Calif. (Age 38) (Claims RCA 6.0) June 1928 to date with California State Div. of Highways as Jun. Highway Engr., and (since July 1936) Asst. Highway Engr.

DELANEY, AUGUSTINE LEO, Cleveland, Ohio. (Age 36) (Claims RCA 5.0) June 1927 to date with Erie R.R., as Jun. Draftsman, Draftsman and (since Feb. 1929) Designer at New York and Cleveland.

DILLENBECK, RONALD BATES, Rockville Centre, N.Y. (Age 35) (Claims RCA 12.2) Jan. 1936 to date Res. Engr., Madigan-Hyland, Engrs., Long Island City; previously Jun. Asst. Engr., Grade 2, Long Island State Park Comm., Belmont Lake, Babylon, N.Y.

DUBOIS, PAUL EMILE, Oklahoma City, Okla. (Age 29) (Claims RCA 1.6) Aug. 1935 to date with City of Oklahoma City, as Chainman, Right-of-Way Engr., Instrumentman, Chf. of Party, Res. Engr. and Designing Engr.

ERICKSON, HAROLD VERNER (Junior), Topeka, Kans. (Age 32) (Claims RCA 5.1) Dec. 1933 to date with Kansas State Highway Comm., as Rodman, Inspector, Instrumentman, Party Chf., Traffic Survey Chf., and (since Dec. 1937) Asst. Engr., and later Associate Engr.

FILLION, STANLEY HERBERT (Junior), Worcester, Mass. (Age 32) (Claims RCA 2.7) June 1930 to June 1933 and July 1934 to date with Worcester Polytechnic Inst., as Instructor in, and (since July 1937) Asst. Prof. of, Civ. Eng.

FREDERICKSON, JOHN HENRY, JR., New Orleans, La. (Age 28) (Claims RCA 4.6) Oct. 1932 to May 1938 and Aug. 1939 to date with Lewis-Chambers Constr. Co., Inc., as Field Engr., and (since Aug. 1939) Engr.; in the interim with R. E. Hazard & Sons, San Diego, Calif., and Jahn & Bressi Constr. Co., Inc., Los Angeles, Calif.

FUHRMAN, RALPH EDWARD (Junior), Washington, D.C. (Age 30) (Claims RC 7.5) Oct. 1937 to date Asst. Supt., Sewage-Treatment Plant, Blue Plains; previously Asst. Public Health Engr., Missouri State Board of Health; Supt., Sewage-Treatment Plants, Springfield, Mo.

GRENNAN, PHILIP MICHAEL, New York City. (Age 32) (Claims RCA 8.2) Nov. 1937 to date Structural Draftsman, Republic Fireproofing Co., Inc.; previously Structural Draftsman, Union Carbide & Carbon Co.; with Poirier & McLane Corporation, Engrs.-Contrs.

GROSS, MICHAEL ALBERT (Junior), Pittsburgh, Pa. (Age 32) (Claims RCA 4.0) Feb. 1937 to date with Pittsburgh & Lake Erie R.R. Co., as Eng. Draftsman and Inspector; previously Senior Draftsman, U.S. Engr. Dept.; Plant and Mixer Inspector, Chainman, Draftsman, Senior Draftsman and Squad Leader, Pennsylvania Dept. of Highways.

HART, FRANCIS COYNE (Junior), Denver, Colo. (Age 32) (Claims RCA 4.2) June 1936 to date with Div. of Water Resources, Bureau of Reclamation as Jun. Engr., and (since June 1937) Asst. Engr.; previously Hydrographer, Office Asst., Special Hydrographer, and Asst. Engr., State Engr.'s Office, State of Colorado.

HATCH, GRAHAM MCFIE, JR. (Junior), Dallas, Tex. (Age 31) (Claims RCA 4.6) Sept. 1935 to date San. Engr. and Asst. Chf., Inspection & San. Div., Public Health Dept.

HINKSON, NEWTON LOWELL, Charleston, S.C. (Age 27) (Claims RCA 1.6) Feb. 1939 to date Hydro-Electric Designer, Harza Eng. Co.; previously with TVA as Asst. Engr. Draftsman and Engr. Draftsman; Draftsman and Rodman, Design Dept., Kansas Highway Comm.

IMBODEN, GEORGE RALPH, St. Louis, Mo. (Age 31) (Claims RCA 5.6 RCM 3.0) Aug. 1933 to date with City of St. Louis as Civ. Draftsman, Asst. Civ. Engr., and (since Jan. 1935) Civ. Engr.

JACKSON, SHERMAN KEITH (Junior), Fort Smith, Ark. (Age 32) (Claims RCA 3.1) April 1931 to date with U. S. Geological Survey as Jun. Hydr. Engr., Asst. Hydr. Engr., and (since March 1940) Associate Hydr. Engr.

JOHNSON, ARTHUR BRADFORD, Los Angeles, Calif. (Age 33) (Claims RCA 2.2) Jan. 1929 to date with Dept. of Water & Power, City of Los Angeles, as Jun. Topographical Draftsman, and since Oct. 1935 Topographical Draftsman.

KINSELLA, JOHN RICHARD, Newport, Ky. (Age 34) (Claims RCA 10.5 RCM 2.3) May 1934 to Jan. 1936 Asst. City Engr., and Jan. 1938 to date City Engr., City of Newport, Ky.; in the interim County Surveyor, Campbell County, Ky.

KRUSE, MARVIN OTTO (Junior), Muscatine, Iowa. (Age 32) (Claims RCA 1.1 RCM 0.4) July 1939 to date Asst. Engr., Stanley Eng. Co.; previously Asst. Engr., Young & Stanley, Inc., Engrs.; Field Representative for Iowa State Planning Board, Ames, Iowa.

LEGATSKI, LEO MAX, College Station, Tex. (Age 33) (Claims RCA 3.5) Sept. 1938 to June 1939 and Sept. 1939 to date Instructor in Civ. Eng., Agricultural and Mechanical Coll. of Tex.; previously Bridge Designer, Michigan State Highway Dept.; Structural Draftsman and Designer, City of Midland, Mich.

LEVEL, ANDREW DUARTE, JR. (Junior), La Guaira, Venezuela, S.A. (Age 31) (Claims RCA 7.5) May 1938 to date Asst. Res. Engr., Ministry of Public Works; previously Eng. Supervisor, WPA, and Engr., Wigton-Abbott Corporation, both of New York City.

LOGAN, ROY, Baltimore, Md. (Age 33) (Claims RCA 4.1) Sept. 1932 to date with U.S. Engr. Office, as Sub-Inspector, Inspector, Jun. Engr., Asst. Engr., and (since May 1939) Associate Engr.

LUNDQUIST, EUGENE EDWARD (Junior), Hampton, Va. (Age 32) (Claims RCA 8.0 RCM 0.7) March 1929 to date with National Advisory Comm. for Aeronautics, Langley Field, Va., as Jun. Civ. Engr., Asst. Civ. Engr., Associate Aeronautical Engr., and (since July 1939) Aeronautical Engr.

MURDICHIAN, KARMY KARNIG (Junior), Brooklyn, N.Y. (Age 32) (Claims RCA 4.8 RCM 1.6) Nov. 1939 to date Superv. Engr., E. J. McCormick, Inc., Cons. Engrs.; previously Asst. Engr., PWA, Eng. Dept., New York City; Asst. Engr., Constr. Dept., Foundation Div., New York World's Fair 1939 Inc.; Structural Designer, Constr. Div., Dept. of Parks, New York City.

NEVILLE, JAMES LISLE, Russell, Kans. (Age 34) (Claims RCA 4.6 RCM 2.8) July 1934 to Jan. 1935 and Oct. 1935 to date with Paulette & Wilson, Prof. Engrs., Topeka, Kans., as Superv. Engr., etc., and since June 1937 Engr.

PAYNE, EUGENE BENNETT (Junior), Fresno, Calif. (Age 32) (Claims RCA 2.1) June 1937 to date with Shell Oil Co. Inc., San Francisco as Structural Draftsman, and later Div. Engr.; previously Contr., Oakland, Calif.; Jun. Bridge Engr., and Asst. Bridge Engr., California Bridge Dept., San Francisco–Oakland Bay Bridge Div.

PIERCE, ALTON LOUIS (Junior), San Francisco, Calif. (Age 32) (Claims RCA 5.1) April to June 1934 and March 1938 to date with U.S. Engrs., as Dredging Inspector, Prin. Engr. Aide, and since Jan. 1940 Jun. Engr.; in the interim with Seaboard Eng. Co., U.S. Bureau of Biological Survey, and St. Louis County Highway Dept.

RAGAINI, FRANK, West Haven, Conn. (Age 34) (Claims RCA 5.0 RCM 2.1) March 1930 to March 1938 with Blair and Marchant, Inc., and March 1938 to date with Clarence M. Blair, Inc.

RANKIN, ARDERY ROBERT (Junior), Washington, D.C. (Age 29) (Claims RCA 1.3) June 1931 to date with Public Roads Administration (formerly Bureau of Public Roads) as Jun. Highway Engr., Asst. Highway Engr., and since Jan. 1939 Research Engr.

RAUCHENSTEIN, FRED, Jackson Heights, N.Y. (Age 57) (Claims RCA 10.6) April to July 1939 Field Engr., Butler Constr. Co., St. Paul, Minn.; previously Supt. of Constr., Ellerbe Co., and on design with C. H. Johnston, Archt., both of St. Paul, Minn.; Jun. Structural Engr., Procurement Div., Washington, D.C.; Civ. Engr. with C. S. Whitney, Milwaukee, Wis.

REED, GEORGE DEWEY, Louisville, Ky. (Age 40) (Claims RCA 8.4) Feb. 1939 to date Asst. Public Health Engr., U.S. Public Health Service; previously Water-Works Engr., Pennsyl-

vania Public Utilities Comm., Harrisburg, Pa.; Mechanic, Huntington Garage; Engr., The Pitometer Co., New York City.

REILL, JAMES BERTRAND, Bethlehem, Pa. (Age 35) (Claims RCA 5.0) July 1929 to date with McClintic-Marshall Corporation (now Bethlehem Steel Co.) as Draftsman, Field Engr., and since Aug. 1931 Designer (Structural), Fabricated Steel Constr., Eng. Dept.

SOLER-LOPEZ, ERNESTO ANTONIO (Junior), San Juan, Puerto Rico. (Age 30) (Claims RCA 7.2) May 1931 to Aug. 1932, Dec. 1933 to March 1936 and Dec. 1937 to date with War Dept., U.S. Engr. Office, as Draftsman, and (since Dec. 1937) Asst. Engr.; in the interim Dist. Engr., Puerto Rico RA, Mayaguez Dist., and Asst. Civ. Engr., Fajardo (Puerto Rico) Sugar Co.

TRIPP, EDWARD, Columbus, Ohio. (Age 33) (Claims RCA 4.8) June 1929–Nov. 1935 Jun. Engr. and Dec. 1935 to date Asst. Engr., U.S. Geological Survey.

WEEKS, WILLIAM ALFRED, Ridgewood, N.Y. (Age 33) (Claims RCA 2.7) May 1938 to date Eng. Asst., New York City Tunnel Authority; previously Engr. Asst., Board of Transportation, and Station Master on City Subway, New York City; Draftsman, Computer, and Structural Draftsman, Gibbs & Hill, Cons. Engrs.

WELLS, WILLIAM LEONIDAS (Junior), Vicksburg, Miss. (Age 29) (Claims RCA 4.3 RCM 0.4) Aug. 1933 to Oct. 1935, July 1936 to Aug. 1937 and Oct. 1939 to date with U.S. Waterways Experiment Station, as Inspector, Jun. Engr., and (since Oct. 1939) Asst. Engr.; since Oct. 1939 also Cons. Engr. on soil mechanics problems.

WENGER, FRANK EDWARD, St. Louis, Mo. (Age 34) (Claims RCA 7.2 RCM 2.0) April 1938 to date with Russell & Axon, Cons. Engrs., as Designer, and later Office Engr.; previously with National Park Service as Gen. Constr. Foreman and Project Supt.

WILLETT, CHARLES KENNETH, Dixon, Ill. (Age 35) (Claims RC 8.7 D 9.1) Jan. 1934 to date Cons. Engr. in private practice on farm drainage, road and streets, sewers, water-works.

YANDA, ALFRED DANIEL (Junior), Cleveland, Ohio. (Age 32) (Claims RCM 11.0) May 1927 to date with Cuyahoga County Engr., as Senior Draftsman, Senior Asst. Civ. Engr., and (since April 1929) acting as Asst. to Chf. Draftsman in charge of Highway Dept., also Engr.

YOUNG, FRANCIS DEWEY, Cleveland, Ohio. (Age 40) (Claims RCA 6.2 RCM 8.5) May 1925 to July 1930 and May 1933 to date Engr., Gascoigne and Associates; in the interim Res. Engr., City of Cleveland, Ohio.

APPLYING FOR JUNIOR

BACKUS, EUGENE STEPHEN, Brooklyn, N.Y. (Age 23) 1938 B.C.E., Brooklyn Pol. Inst.; March 1939 to date with City of New York as Topographic Draftsman, and (since Sept. 1939) Jun. Engr., Dept. of Public Works.

BARTZ, ELLWOOD LEWIS, Detroit, Mich. (Age 22) 1940 B.S. in Civ. Eng., Univ. of Wis.

BOWER, WILLIAM EDWARD, Denver, Colo. (Age 23) 1937 B.S.C.E., Univ. of Colo.; Aug. 1937 to date Structural Draftsman and Estimator, The Midwest Steel & Iron Works Co.

BOWERS, WILLIAM C., Cranston, R.I. (Age 28) (Claims RCA 3.0) Nov. 1938 to date Jun. Civ. Engr., U.S. Army Engrs., Providence, R.I.; previously Jun. Highway Engr., Illinois State Highway Dept., Dixon, Ill.

CAMPBELL, WILLIAM WARD, Girard, Ohio. (Age 26) 1940 B.C.E., Ohio State Univ.

CAPESIUS, VIRGIL MICHAEL, Fremont, Nebr. (Age 23) 1940 B.S. in C.E., Iowa State Coll.

DUTHIE, JOHN MILNE, Bakersfield, Calif. (Age 29) (Claims RC 3.4) 1940 B.S. in C.E., Univ. of So. Calif.; at present with his father, a registered civil engineer.

EVANS, CHARLES ANDREW, Chattanooga, Tenn. (Age 23) 1938 B.S. in Civ. Eng., Univ. of N.C.; Aug. 1938 to date Jun. Eng. Aide and Asst. Eng. Aide, TVA.

FLANDERS, DONALD LEE, Ellsworth, Kans. (Age 24) 1940 B.S. in C.E., Kans. Univ.

GANICK, SAUL SAMUEL, Brighton, Mass. (Age 29) (Claims RCA 4.0) June 1935 to date with U.S. Engr. Office, Boston, Mass, as Senior Computer, Chf. Computer, and (since Aug. 1939) Asst. Engr.

GOODRICH, FRANK NOBILING, Eugene, Ore. (Age 27) (Claims RCA 1.0) 1938 B.S. in Civ. Eng., Mo. School of Mines; Sept. 1939 to date Inspector, U.S. Engr. Dept.; previously Rodman, Recorder, and Jun. Engr., U.S. Geological Survey, Rollo, Mo.

HANNON, LUCIUS, JR., Birmingham, Ala. (Age 21) 1939 B.S. in Civ. Eng., Ga. School Tech.; Aug. 1939 to date with Rail Transportation Works, Tennessee Coal, Iron & R.R. Co., Ensley, Ala., as Student Engr., and since Feb. 1940 Jun. Engr.

HITEMAN, LESLIE HENRY, Cincinnati, Ohio. (Age 28) (Claims RCA 0.4 RCM 0.1) June to Sept. 1936, April to July 1938 and Sept. 1938 to date with U.S. Engr. Office as Surveyman, Superv. Draftsman, Topographical Draftsman, Inspector, and since Jan. 1940 Jun. Civ. Engr.; in the interim Estimating Engr., Automatic Sprinkler Corporation of America; previously Instrumentman, Turrel & Larson.

ILLINGWORTH, LELAND RUSSELL, Concord, Calif. (Age 25) 1939 B.S. in Civ. Eng., Univ. of Calif.; Jan. 1940 to date Jun. Engr., Shell Chemical Co.

JACOBSEN, WILLIAM BYRON, Boone, Iowa. (Age 27) 1940 B.S. in C.E., Iowa State Coll.

MCCRACKIN, THOMAS HUNTER, JR., Champaign, Ill. (Age 23) 1940 B.S. in C.E., Univ. of Ill.; Feb. 1940 to date Laboratory Asst., Univ. of Illinois.

MCFARLAND, WILBURN JAYE, JR., East Lansing, Mich. (Age 26) Sept. 1937 to date with Michigan State Coll., as Graduate Asst., and since Sept. 1938 Instructor; previously Levelman, International Boundary Comm., San Benito, Tex.; Rodman and Instrumentman, Sun Oil Co., Dallas, Tex.

MCGAVOCK, CECIL BILLUPS, JR., Chattanooga, Tenn. (Age 27) Aug. 1935 to date with TVA as Jun. Geologic Aide, Asst. Geologist Aide, Jun. Geologist, and (since July 1939) Asst. Geologist (P-2).

MILLER, VICTOR ALDEN, Coalinga, Calif. (Age 23) 1938 B.S. in Civ. Eng., Univ. of Calif.; Jan. 1938 to date Technical Trainee, Standard Oil Co. of California.

MUELLER, RALPH WILLIAM, Mobile, Ala. (Age 28) Sept. 1938 to date Jun. Engr., U.S. Engrs.; previously with U.S. Waterways Experiment Station, Vicksburg, Miss., as Laborer, etc.

NICOLI, FRANK ANTHONY, Springfield, Mass. (Age 28) (Claims RC 1.6) Sept. 1935 to date Asst. Engr., Metcalf & Eddy, Cons. San. Engrs., Boston, Mass.; previously Chf. of Survey Party, Blackstone (Mass.) River Valley Survey.

OCVIRK, FRED WILLIAM, Champaign, Ill. (Age 26) 1938 B.S., Wayne Univ. M.S. in C.E., Univ. of Illinois (to be conferred in June 1940).

ORTON, DONALD WHITNEY, Beaver, Pa. (Age 29) April 1937 to date Draftsman and Shop Detailer, H. H. Robertson Co.; previously with TVA as Apprentice Draftsman, Jun. Eng. Draftsman, Jun. Eng. Aide, Asst. Eng. Draftsman and Eng. Draftsman; Rodman, Chainman and Note Keeper, Saratoga County Highway Dept.

PETERSON, BURDETTE ERNEST, Chicago, Ill. (Age 23) 1938 B.S. in C.E., Armour Inst. Tech.; Feb. 1939 to date Jun. Topographic Engr., U.S. Geological Survey; previously Chainman, Chicago, Rock Island and Pacific R.R. Co.; Draftsman, Major Equipment Co.

PLOMTEAUX, CHARLES HENRY, JR., San Jose, Calif. (Age 24) 1940 B.S. in Civ. Eng., Univ. of Calif.

ROMBERGER, FRANKLIN PIERCE, Somerset, Pa. (Age 23) 1938 B.S.C.E., Bucknell Univ.; July 1938 to date with Pennsylvania Turnpike Comm., as Chainman, Instrumentman, and (since June 1939) Tunnel Instrumentman.

ROSEN, ISIDORE SAM, Pittsburgh, Pa. (Age 24) 1938 B.C.E., Cooper Union; July 1939 to date Jun. Civ. Engr., U.S. Engr. Office, War Dept.

ROSS, HAMILTON MURRAY, JR., Pottstown, Pa. (Age 26) (Claims RCA 3.6) July 1936 to date with Bethlehem Steel Co., as Structural Steel Detailer, Field Engr., Erection Dept., and (since Jan. 1939) Asst. to Head of Bldg. Specialties Dept.

SMITH, ROBERT DEMPSTER, Berkeley, Calif. (Age 22) 1939 B.S. in Civ. Eng., Univ. of Calif.

SWANSON, LLOYD HAROLD, Lincoln, Nebr. (Age 23) 1940 B.S. in C.E., Univ. of Nebr.

TURTING, WILLIAM FRANCIS, Wheaton, Minn. (Age 25) (Claims RCA 0.3) 1938 B.S. in C.E., Univ. of N.Dak.; Nov. 1939 to date Eng. Aide, U.S. Engrs., St. Paul Dist.; previously Instrumentman, Levelman, Computer, and Inspector, North Dakota State Highway Dept.

WATTERS, PAUL WALTER, Ames, Iowa. (Age 23) 1940 B.S., Iowa State Coll.

YATES, THOMAS JACKSON, Jeffersonville, Ind. (Age 22) 1939 B.C.E., Univ. of Louisville.

The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

Men Available

These items are from information furnished by the Engineering Societies Employment Service, with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 132 of the 1940 Year Book of the Society. To expedite publication, notices should be sent direct to the Employment Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York Office, unless the word Chicago or San Francisco follows the key number, when it should be sent to the office designated.

CONSTRUCTION

CIVIL ENGINEER; Assoc. M. Soc. C.E.; graduate civil engineer; graduate in business administration; New Jersey licensed engineer; 1st lieutenant, Corps of Engineers, U.S. Army Reserve; 13 years experience in building construction, highway construction, and land surveying. Desires permanent connection. C-680.

CIVIL ENGINEER; Assoc. M. Soc. C.E.; 35; married; 3 1/2 years college; 8 1/2 years road, bridge construction, design, all types surveying, mapping, drafting, all types testing experience; 1 year drafting, tracing, mechanical and electrical; 3 1/2 years with federal government, designing, estimating, supervising construction, handling heavy equipment, budgetary control, surveying, mapping. Location immaterial; available immediately. C-688.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 36; 14 years experience in construction of buildings, bridges, sewage disposal plants and sewers, subways, highways, surveys, design, estimating. Connected with government, but desires change with large contracting or consulting firm. Available on two weeks' notice. Location immaterial. C-690-349-Chicago.

WATER WORKS ENGINEER; M. Am. Soc. C.E.; registered Pennsylvania, West Virginia; over 25 years experience in design of water works, hydraulic structures, construction of all types of water works structures, including considerable sewerage disposal design and construction; extensive valuation experience with utilities and public service commission. Now available, any capacity, any location. C-693.

GENERAL CONSTRUCTION AND DESIGN ENGINEER, M. Am. Soc. C.E.; 48; registered in Pennsylvania; 24 years experience in steel and concrete design, supervision of construction, supervision of engineering personnel, estimating, planning; bridges, highways, sewers, steel mills. Prefers position with owner and N.E.; open for immediate engagement anywhere. C-696.

DESIGN

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 41; single; registered in Pennsylvania; 12 years experience in reinforced concrete and structural steel

design; capable of handling anything from a sewer to a skyscraper. Location not important; available immediately; connection with contractor acceptable. C-697.

Executive

CIVIL ENGINEER; M. Am. Soc. C.E.; accustomed to executive and administrative responsibility in handling men and dealing with the public; diversified industrial and construction background; paper mills, chemical plants, water works, and sanitation plants; 14 years successful teaching experience. Available on short notice; will consider any location. C-686.

CIVIL ENGINEER; M. Am. Soc. C.E.; graduate; married; 25 years experience; industrial plants, steel, chemical; also gas, electric utilities; design, construction, maintenance; power, processing, conveying, producing units; buildings; raw material, fuel storage structures for liquids, gases, solids; plant utility piping; gas, air, steam, water; heating, ventilating, drainage, sanitation; engineering administrative control; public works projects. C-691.

Junior

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 28; single; B.S.C.E., University of Tennessee; 9 months experience in triangulation; $2^1/_2$ years experience highway materials and construction; 16 months experience hydraulic model studies; 13 months experience writing engineering reports. Desires permanent position with future with engineering, materials, or contracting firm. Location immaterial. C-681.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 28; married; 5 years junior engineer, consulting office. Experience in transportation surveys, highway planning and design, regional planning, hydraulics, irrigation, flood control; $2^1/_2$ years surveying and construction. Wishes connection in Southwest; qualified grade 2, civil engineering, February 1939. Available immediately. C-682-403-A-4-San Francisco.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 25; married; B.S., Columbia University; C.E., Columbia University; Theta Tau; high scholastic record; $1^1/_2$ years experience in field, large foundation jobs; 9 months experience as job engineer and job office manager. Desires job with opportunity for advancement to position of responsibility. Will go anywhere. Available at once. C-683.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 28; B.C.E.; M.C.E.; $1^1/_2$ years general plant layout, design, and construction; 3 months as designer and detailer on railroad bridges; at present instructor in structural theory, reinforced concrete, surveying. Desires temporary engagement from June 1 to September 1. C-685.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 26; married; B.S.C.E., Rutgers University, 1938; 10 months supervising survey party on road location; 6 months drafting on arsenal utility and county maps; 3 months field engineer on oil tank base construction; 8 months supervising revision of borough tax maps. Available at once. C-689.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 25; married; S.B.C.E. Massachusetts Institute of Technology; 6 months experience in structural design; also experienced in topographic and hydrographic surveying. Now employed; desires position with construction company or with hydraulic, structural, or consulting engineering firm; location immaterial. C-695.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 24; desires work with general contractor; one year varied experience in building construction; six months of mechanical drafting. Salary secondary; location immaterial. C-698.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 28; married; B.S. and M.S. degrees, with major in sanitary engineering; 4 years engineering and research with state planning agency; 1 year topographic mapping; 6 months sanitary engineering. Desires experience in municipal engineering or administration; available upon proper notice to employer. C-699.

Municipal

CIVIL ENGINEER; Jun. Am. Soc. C.E.; B.C.E., Ohio State University; Ohio professional engineer's license; 31; married; 8 years highway experience; 6 years preparation of plans and designing; 2 years surveys and project engineer; 4 years responsible charge. Interested in highway safety engineering. Employed but available on short notice. References. C-684.

SAFETY ENGINEER; M. Am. Soc. C.E. Available for part-time service anywhere east of Kansas City and north of Louisville. C-687.

CIVIL ENGINEER; M. Am. Soc. C.E.; 54; vigorous good health; 30 years broad experience in hydraulic and sanitary engineering, particularly water supply; experience includes primary responsibility in preliminary investigation, design, and construction on large work and small; well founded in critical economic studies relating to basic problems of design. Available immediately. C-692.

Teaching

STRUCTURAL PROFESSOR; Assoc. M. Am. Soc. C.E.; 34; married; registered professional engineer; B.S., M.S.; member of several technical and honorary societies; publications on technical and educational matters. Available July 1940. C-694.

RECENT BOOKS

New books of interest to Civil Engineers donated by the publishers to the Engineering Societies Library, or to the Society's Reading Room, will be found listed here. A comprehensive statement regarding the service which the Library makes available to members is to be found on page 122 of the Year Book for 1940. The notes regarding the books are taken from the books themselves, and this Society is not responsible for them.

MECHANICS OF LIQUIDS, an Elementary Text in Hydraulics and Fluid Mechanics. By R. W. Powell. New York, Macmillan Co., 1940. 271 pp., illus., diagrs., charts, tables, $9^1/_2 \times 6$ in., cloth, $3.50.

Believing that the time usually available and the mathematical preparation of most students make it unwise to attempt a thorough presentation of fluid mechanics in an introductory course, the author has confined this work to non-compressible fluids. The result differs very little from the old hydraulics except in point of view and the introduction of recent improvements. The book provides a brief course emphasizing principles and approaching the subject historically.

(THE) MODERN RAILWAY. By J. H. Parmelee. New York and London, Longmans, Green & Co., 1940. 730 pp., diagrs., charts, tables, maps, 9×6 in., cloth, $4.

This definitive treatment of rail transport in our time covers the historical background, operation problems and processes, and public relations. The wide range of the work takes in the physical plant, human activities, finance, and competitive complications. There are many tables and charts, and digests of federal railway legislation and federal railway labor legislation are appended.

NATIONAL CONFERENCE ON PLANNING, Proceedings of the Conference held at Boston, Massachusetts, May 15–17, 1939. Chicago, American Society of Planning Officials, 1939. 166 pp., $9^1/_2 \times 6$ in., cloth, $2.

Participants in the conference were the American Institute of Planners, the American Planning and Civic Association, the American Society of Planning Officials, and the National Economic and Planning Association. Over thirty papers were presented, dealing with various problems of community reclamation, industrial migration, obstacles to planning, rural planning, public works, etc.

PNEUMOCONIOSIS (Silicosis), the Story of Dusty Lungs, a Preliminary Report. By L. G. Cole and W. G. Cole. New York, John B. Pierce Foundation, 1940. 100 pp., illus., charts, 11×8 in., cloth, $1.

For several years the Doctors Cole have been investigating this subject under the auspices of the John B. Pierce Foundation. This volume presents the conclusions reached, many of which, the authors say, are not in accord with the accepted ideas. The cause of the disease, its physiological effects, its diagnosis, the social and economic problem that it presents, and the legislative and judicial treatment that should be provided are discussed.

SOIL MECHANICS AND FOUNDATIONS. By F. L. Plummer and S. M. Dore. New York and Chicago, Pitman Publishing Corp., 1940. 473 pp., illus., diagrs., charts, tables, 9×6 in., cloth, $4.50.

The aim of this work is to correlate, systematize, and simplify the increased understanding of the performance of soils which new methods of research work have produced, and to present the information in convenient form for use by engineers and students. The principles of soil mechanics, the terminology, and the types of tests employed are described, and the ways in which the results are used in foundation work, in retaining walls, and highway and dam construction are presented. A bibliography is included.

TRAINING PROCEDURE. By F. Cushman. New York, John Wiley & Sons, 1940. 230 pp., charts, tables, $7^1/_2 \times 5$ in., cloth, $3.

The author discusses the problems encountered in planning, organizing, operating, and maintaining efficient training programs in industrial, business, and public-service organizations. The discussion is limited to employed personnel, and the principal objective is improvement in the performance of work. Much practical information is given in the text and appendixes.

CURRENT PERIODICAL LITERATURE

Abstracts of Magazine Articles on Civil Engineering Subjects

Selected items for the current Civil Engineering Group of the Engineering Index Service, 29 West 39th Street, New York, N.Y. Every article indexed is on file in The Engineering Societies' Library. Photoprints will be supplied by this library at the cost of production, 25 cents per page, plus postage, or technical translations of the complete text may be obtained at cost.

BRIDGES

ABUTMENTS. Precast Concrete Slabs Face Bridge Abutments, L. G. Sumner. *Eng. News-Rec.*, vol. 124, no. 1, Jan. 4, 1940, pp. 61–63. Use of thin factory-made exposed aggregate slabs of unusually strong and dense concrete for abutment facing on grade separation bridges on Merritt Parkway in Connecticut; manufacture, installing, and advantages of slabs; costs; concrete slab specifications.

BASCULE, NETHERLANDS. Bascule Railway Bridge Over South Beveland Canal on Roosendaal-Flushing Line, near Vlake, Holland, T. W. Mundt. *Int. Ry. Congress Assn.—Bul.*, vol. 21, no. 11, Nov. 1939, pp. 1031–1047. Swing bridge replaced by new structure at higher level; work consists of two new approaches in reinforced concrete, two fixed lattice girder metal trough bridges, and two single track bascule bridges; bascule bridges are of solid web main girder type with top flooring; illustrations and diagrams given.

CONCRETE, CONSTRUCTION. Baustelleneinrichtungen grosser Massivbruecken, H. Rietli. *Bautechnik*, vol. 17, no. 53/54, Dec. 15, 1939, pp. 649–661. Review of German practice in design and operation of construction plants for erection of large concrete bridges, particularly multiple arch bridges.

CONCRETE GIRDER. Ueber die Berechnung schiefer Eisenbetonbalkenbruecken, R. Seiler. *Forscherarbeiten auf dem Gebiete des Eisenbetons*, no. 48, 1939, 40 pp., price, 5,80 rm. Theoretical mathematical discussion of design of skew reinforced concrete bridges of girder type; approximate methods of design; numerical examples.

FLOORS. Redecking Old Bridge with Treated Timber. *Eng. News-Rec.*, vol. 124, no. 1, Jan. 4, 1940, pp. 44–46. Method of placing durable treated timber deck on 35-year-old Morrison Street bridge in Portland, Ore.; details of deck construction on trestle approach and on steel channel spans; asphalt pavement.

HIGHWAY, DESIGN. Composite Steel and Reinforced Concrete Construction for Highway Bridges, C. P. Cueni. *Roads & Streets*, vol. 82, no. 12, Dec. 1939, pp. 48–49. Principles of design of spiral shear reinforcements for transmitting all horizontal shear for steel section into concrete slab; example of design.

MILITARY. Use of Weak Bridges for Heavy Loads, Bujard. *Roy. Engrs. J.*, vol. 53, Dec. 1939, pp. 561–565. Methods of adapting highway bridges for heavy military traffic; simple method for calculating carrying capacity of wood and steel bridges. Translation of article published in *Vierteljahreshefte fuer Pioniere*, May 1939.

PLATE GIRDER, FRANKFORT, KY. Building Beautiful Bridge, E. D. Smith. *Eng. News-Rec.*, vol. 123, no. 25, Dec. 21, 1939, pp. 59–61. Design and construction of deck girder highway bridge, at Frankfort, Ky., having 3-span continuous unit of 474 ft that received award of American Institute of Steel Construction for most beautiful bridge of its class; foundation construction; deflections of continuous unit; roadway lighting.

RAILROAD CONSTRUCTION, CUTOFF. Rock Island Completes Its "Samson of Cimarron." *Ry. Age*, vol. 108, no. 4, Jan. 27, 1940, pp. 202–207 and 223. Description of Arkalon cutoff on Chicago-California main line of this road, involving 3-tier fills and 1,269-ft river bridge across valley of Cimmarron River.

RAILROAD CONSTRUCTION, EMERGENCY. New Liège By-Pass Line. *Engineer*, vol. 168, no. 4380, Dec. 22, 1930, p. 622. Account of how authorities dealt with disaster caused on Aug. 31, 1939, by violent thunderstorm to Liège-"Val Benoit" Bridge; it was decided to proceed immediately with completion of Liège by-pass line that had been started long ago; on Sept. 2 work was undertaken to complete railway; since Sept. 17 river navigation has been reestablished; temporary double track railway bridge is being built in Liège across river.

RAILROAD, RAIL BUFFERS. Der Ringfeder-Schienenpuffer, Bloss. *Organ fuer die Fortschritt des Eisenbahnwesens*, vol. 94, no. 16, Aug. 15, 1939, pp. 315–320. Design of an experience with annular spring buffers placed under rails crossing bridges, to reduce force of impact from entering train.

STEEL, STRENGTHENING. Strengthening Old Bridges to Meet Present-Day Demands, G. A. Haggander. *Ry. Eng. & Maintenance*, vol. 36, no. 2, Feb. 1940, pp. 80–83. Author discusses methods of strengthening various types of bridges and trestles to meet requirements of modern traffic imposed by heavier live loads and high speeds, or to strengthen members weakened by effects of corrosion or local deterioration, which may be caused by brine drippings, locomotive gases, or other causes. Before Am. Ry. Bridge & Bldg. Assn.

STEEL TRUSS, CLEVELAND, OHIO. Features of Cleveland's Main Avenue Bridge, J. O. McWilliams, W. E. Blaser, and F. L. Plummer. *Roads & Streets*, vol. 82, no. 12, Dec. 1939, pp. 25–33. Design and construction of new steel truss bridge over Cuyahoga River, Cleveland, Ohio, consisting principally of 10 spans varying in length from 200 to 400 ft; total length 2,520 ft; total estimated costs including approaches $7,200,000.

BUILDINGS

DESIGN. La Casa che Meglio Resiste alle Offese Aeree, G. Stellingwerff. *Ingegnere*, vol. 13, no. 12, Dec. 1939, pp. 1001–1010. Discussion on design of buildings of maximum resistance to aerial bombing, based on experience of Spanish War and on observations in earthquake countries.

CONCRETE

BUILDING MATERIALS, SPECIFICATIONS. Report of Committee 8—Masonry. *Am. Ry. Eng. Assn.—Bul.*, vol. 41, no. 415, Jan. 1940, pp. 351–406, supp. sheet. Revision of manual; specifications and principles of design of plain and reinforced concrete; progress in science and art of concrete manufacture; specifications for pile foundations and for lining railway tunnels with brick; rating of reinforced concrete bridges; progress in cement manufacture and testing; specifications for placement of concrete culvert pipe; pressure grouting.

CONSTRUCTION. Case Hardening Concrete with Absorptive Form Lining. *Western Construction News*, vol. 15, no. 2, Feb. 1940, pp. 41–43. Review of U.S. Bureau of Reclamation research for development of absorptive form lining as means of eliminating excess water and entrained air in concrete, for producing improved surface characteristics; observations made with transparent forms; durability tests; crazing reduced by use of absorptive lining; field tests.

CONSTRUCTION. Plywood Form Panels Re-Used 14 Times in Deep Bridge Piers. *Eng. News-Rec.*, vol. 124, no. 11, Mar. 14, 1940, p. 61. Details of plywood form panels used in construction of cellular concrete piers for Narrows Bridge at Tacoma, Wash.

CONSTRUCTION. Job Problems and Practice. *Am. Concrete Inst.—J.*, vol. 11, no. 4, Feb. 1940, pp. 409–414. Discussion of practical problems of concrete construction, including following: keeping horizontal construction joints moist while carpenters are at work; equipment to lift face forms of dam; compressed air jets as means of placing concrete.

CONSTRUCTION. Progress in Concrete Research. *Eng. News-Rec.*, vol. 124, no. 11, Mar. 14, 1940, pp. 67–70. Abstracts of papers presented before 1940 annual meeting of American Concrete Institute on following subjects: Frost Resistant Concrete, R. B. Young; Rainproof Walls, R. E. Copeland and C. C. Carlson; Ag-

gregate Sorting Machines, W. M. Dunagan; Vibrated vs. Tamped Concrete, G. W. Washa; Concrete Building Tolerances, J. R. Nichols; Ready Mixed Concrete, A. Foster, Jr., J. H. Knopel, H. J. Whitten, and H. F. Thomson.

CONSTRUCTION. Proposed Recommended Practice for Measuring, Mixing, and Placing Concrete, L. H. Tuthill. *Am. Concrete Inst.—J.*, vol. 11, no. 4, Feb. 1940, pp. 329–351. Report of Committee 614 of American Concrete Institute presenting outline of good practices for measuring and mixing ingredients for concrete and for placing finished product; correct and incorrect handling of aggregates in and of mixed concrete; vibration; provision for handling concrete of proper consistency; construction joints; cold weather concreting; hot weather concreting.

CONSTRUCTION, PUMP PLACING. Central Plant Pumps Concrete to Four Buildings. *Construction Methods*, vol. 22, no. 2, Feb. 1940, pp. 40–42, 84, and 86–88. Methods and equipment used in pumping 19,000 cu yd of concrete through pipe lines 900 ft long to four produce buildings erected at Food Market in Kansas City, Kans.; features of central concrete mixing and pumping plant.

DISINTEGRATION. Concrete versus Water, R. C. Bickmore. *Sands, Clays & Minerals*, vol. 3, no. 4, Autumn 1939, pp. 292–296. Action of water on concrete; factors contributing to corrosion; use of aluminous cement; sulfates; sodium chloride; other methods for protection of concrete; sodium silicate and magnesium oxychloride cements; magnesium oxychloride cements. Bibliography.

DISINTEGRATION. Deterioration of Concrete in Contact with Sewage, S. S. Morris. *Instn. Civ. Engrs.—J.*, vol. 4, Feb. 1940, pp. 337–342, supp. plate. Observations and experimental studies on effect of sewage on concrete sewers and tanks in Capetown, South Africa; suggested methods for prevention of disintegration of concrete sewers.

DISINTEGRATION. Ueber die Wichtigkeit der Untersuchung des Baugrundes auf betonagressive Stoffe und ueber die Technik der Probenahme, H. Mueller. *Gesundheits-Ingenieur*, vol. 62, no. 52, Dec. 30, 1939, pp. 733–737. Necessity of investigating building site foundation for presence of substances injurious to concrete; methods of sampling ground water for chemicals injurious to concrete.

MIXING. Design of Concrete Mixes, C. I. Kennedy. *Am. Concrete Inst.—J.*, vol. 11, no. 4, Feb. 1940, pp. 373–400. Outline of rational method for design of concrete mix with respect to workability; examples of application of method to problems of design and to selection of proper aggregate; durability of concrete.

READY-MIXED. Ready-Mixed Concrete Operations in Philadelphia, A. Foster, Jr., H. J. Knopel, and H. J. Whitten. *Am. Concrete Inst.—J.*, vol. 11, no. 4, Feb. 1940, pp. 353–371. History of ready-mixed concrete in Philadelphia; economic considerations that have influenced its successful development; nature of market; problems presented by user; description of plants and organization; methods of technical control; studies for improvement of quality; lime admixture studies; regulations governing use of concrete made at central mixing plants.

DAMS

DESIGN. Low Dams. Washington (D.C.), U.S. Gov. Printing Office, 1939, 431 pp., figs., diagrs., tables, maps. $1.25. Preliminary investigation and hydrologic studies; selection of type of dam; foundations; spillway structures; outlet structures; earth, rock fill, concrete, and masonry gravity dams; single arch dams; buttress dams; timber dams; maintenance and operation; modified rational method of estimating flood flows; soil mechanics; construction methods and specifications; state laws affecting design and construction of low dams.

FOUNDATIONS. Difficult Foundation Problems Met During Conchas Dam Construction, L. T. Grider. *Western Construction News*, vol. 15, no. 2, Feb. 1940, pp. 57–60. Methods of overcoming foundation excavation difficulties in construction of Conchas concrete gravity dam, New Mexico, 235 ft high, due to artesian flow and presence of shale strata.

WATERSTOPS. Rubber Waterstops for Dams, C. P. Vetter. *Eng. News-Rec.*, vol. 124, no. 5, Feb. 1, 1940, pp. 47–49. Description of rubber waterstops, or seals, used in joints in Imperial Dam, recently completed by U.S. Bureau of Reclamation, and in structures built on All-American Canal; details of seals and results of tests as to their functioning under movement along joints in which they are inserted; expected life of rubber seals; accelerated tests; rubber stops under high heads.

FLOOD CONTROL

RELATION TO STREAM POLLUTION. Flood Control and Its Relation to Problems of Stream Pollution, D. F. Horton. *Boston Soc. Civ. Engrs.—J.*, vol. 27, no. 1, Jan. 1940, pp. 42–52. Relation between flood control and stream pollution; jurisdiction of Engineer Department of Corps of Engineers, U.S. Army; Engineer Department procedure in waterway investigations; multiple purpose reservoirs; sanitation benefits from multiple purpose reservoirs; Tygart Reservoir at Pittsburgh; Merrimack River basin flood control.

FLOW OF FLUIDS

CURRENT METERS. Pygmy Current Meter, R. L. Atkinson. *Military Engr.*, vol. 32, no. 181, Jan.-Feb. 1940, pp. 57–58. Features of low-price current meter, developed by U.S. Geological Survey, for measuring flow of streams whose depth is insufficient for use of ordinary current meter.

SEWAGE DISPOSAL, SLUDGE. Properties of Sludge Which Affect Its Discharge Through 24-Inch Pipe, W. Rudolfs and L. E. West. *Sewage Works J.*, vol. 12, no. 1, Jan. 1940, pp. 60–72. Results of experimental studies, made at Elizabeth Valley joint meeting sewage treatment works, of various factors affecting rate of flow and viscosity of sludge through 24-in. pipe 4,400 ft long. Bibliography.

SPILLWAYS. Remarques sur quelques écoulements le long de lits à pente variant graduellement, C. Jaeger. *Schweizerische Bauzeitung*, vol. 114, no. 20, Nov. 11, 1939, pp. 231–234. Theoretical mathematical discussion of flow of water over spillways built on gradually varying slopes. Bibliography. (In French.)

FOUNDATIONS

BRIDGE PIERS, CONSTRUCTION. Long Piles and Floating Caissons for Potomac River Bridge Piers. *Eng. News-Rec.*, vol. 124, no. 9, Feb. 29, 1940, pp. 36–40. Method of driving steel H-piles, 194 ft long, by special 16-ton steam hammer, largest ever built, for foundations of new 2-mile-long Potomac River Bridge at Ludlow Ferry, Md.; main piers are 2-shaft and 4-shaft steel caissons; main superstructure is made up of Wichert trusses, maximum span 800 ft long.

CONSOLIDATION. Chemical Consolidation of Ground in Railway Works, H. J. B. Harding and R. Glossop. *Ry. Gaz.*, vol. 72, no. 5, Feb. 2, 1940, pp. 147–151. Examples of value of chemical consolidation in extension of Central Line tube of London Passenger Transport Board; chemical injections; foundation strengthening; chemical consolidation for tube under river, and at mile end station; diagrams and illustrations given.

DAMS. Large Peg Model Reproduces Damsite Borings, A. V. Lynn and R. F. Rhoades. *Eng. News-Rec.*, vol. 124, no. 11, Mar. 14, 1940, p. 54. Construction of peg model of unusual dimensions, indicating conditions encountered in boring exploration for Kentucky Dam under construction by Tennessee Valley Authority near Paducah, Ky.; every foundation exploration hole is represented by steel rod painted to show materials and cavities encountered.

DRIVING. Exécution de fondations au Brésil au moyen de pieux Franki mixtes. *Technique des Travaux*, vol. 16, no. 1, Jan. 1940, pp. 20–24. Driving of so-called "mixed" Franki concrete piles for foundation of fishing dock in Rio de Janeiro, Brazil.

PILES, DRIVING. Dynamic Pile Driving Formulas, A. E. Cummings. *Boston Soc. Civ. Engrs.—J.*, vol. 27, no. 1, Jan. 1940, pp. 6–27. Critical review of several dynamic pile driving formulas.

HYDRAULIC ENGINEERING

HISTORY. Leonardo da Vinci e l'Idraulica del Rinascimento, C. Zammattio. *Annali dei Lavori Pubblici*, vol. 77, no. 10, Oct. 1939, pp. 1025–1034. Review of contributions of Leonardo da Vinci to hydraulic science and engineering of Renaissance period in Italy.

HYDRAULICS. Mathematical Theory of Irrotational Translation Waves, G. H. Keulegan and G. W. Patterson. *U.S. Bur. Standards—J. Research*, vol. 24, no. 1, Jan. 1940 (RP 1272), pp. 47–101. First paper of series on motion of flood waves and other waves of translation in open channels, for which forces of fluid friction are negligible with respect to inertia and gravitational forces; irrotational motion of perfect liquid in horizontal rectangular canal when original surface is disturbed. Bibliography.

HYDRAULICS. River Control and Water Storage. *Engineer*, vol. 169, nos. 4382 and 4383, Jan. 5, 1940, pp. 10–12, and Jan. 12, pp. 33–34, supp. plates. Review of developments in various civil engineering works of hydraulic nature, including water works, irrigation, flood control, and hydroelectric power.

RIVERS, IMPROVEMENT. Model Study of Tidal Currents in East River, New York. *U.S. War Dept.—Corp. Engrs.—Tech. Mem. Nos. 125–123*, Apr. 3, 1939, 56 pp., supp. sheets. Final report on model study for improvement of current alignments and flow conditions in East River, Port of New York, in interests of navigation by large ships, including those of U.S. Navy; technique of model study; verification of model; tests of proposed improvement plans; analysis of test results.

HYDROELECTRIC POWER PLANTS

FRANCE. L'aménagement du Haut-Rhone Français, P. Calfas. *Génie Civil*, vol. 116, nos.

2996 and 2997, Jan. 13, 1940, pp. 21–27, and Jan. 20, pp. 45–46. Development of Upper Rhone River in France for hydroelectric power, including construction of Genissiat concrete gravity dam, 100 m max height; construction of concrete-lined tunnel for river diversion; features of spillway and of power plant incorporated in dam; development of irrigation facilities on lower Rhone River affecting area of 740 sq km.

SWITZERLAND. Zum Vollausbau des Lungernsee-Kraftwerkes. *Schweizerische Bauzeitung*, vol. 114, no. 21, Nov. 18, 1939, pp. 243–251. Symposium on operation of recent extension of Lungern Lake hydroelectric development of Centralschweizerische Kraft-Werke, including historical introduction tracing development of project; report on shore movements and water level fluctuation of Lungern Lake, by L. Bendel; description of new hydraulic equipment, by E. Habluetzel; report on construction of new water power tunnel, 6.5 km long; etc.

HYDROLOGY AND METEOROLOGY

RAIN AND RAINFALL, PERIODICITY. Portentous Drought in Making, H. P. Gillette. *Water Works & Sewerage*, vol. 87, no. 1, Jan. 1940, pp. 38–39. Discussion of geological indications of cycles in rainfall, suggesting instability of historic climate.

RESERVOIRS, SILT. Silting of Reservoirs, L. S. Hall. *Am. Water Works Assn.—J.*, vol. 32, no. 1, Jan. 1940, pp. 25–42. Description of results of measurements of silt deposits in various reservoirs owned by East Bay Municipal Utility District, Oakland, Calif.; comparison of rates of silting in other reservoirs; outline of proposed methods of controlling rate of erosion on District's watersheds; reservoir sedimentation surveys; life of District reservoirs. Bibliography.

RUNOFF. Investigation of Rainfall and Runoff, G. T. Thompson. *Commonwealth Engr.*, vol. 27, no. 5, Dec. 1, 1939, pp. 170–172. Discussion of factors affecting runoff; erosion and siltation data collected at Coliban River Catchment, Victoria.

SOILS, EROSION. Soil Erosion on Slopes, R. D. Murphy. *Roads & Streets*, vol. 83, no. 2, Feb. 1940, pp. 60 and 63–64. Review of methods of soil erosion control developed by Department of Public Works of Massachusetts; control of surface water; prevention of erosion due to rainfall; practical examples of soil treatment for prevention of erosion on highway slopes.

VIBRATIONS, MEASUREMENT. Le Oscillazioni e Vibrazioni nel Suolo, nei Fabbricati e nelle Macchine, E. Oddone. *Annali dei Lavori Pubblici*, vol. 77, no. 10, Oct. 1939, pp. 1038–1051. Mathematical analysis of vibrations; features of various types of seismographs and other instruments for measurement of intensities and frequencies of vibrations in ground, buildings, and machinery.

INLAND WATERWAYS

CANALS, BELGIUM. La section Lanaye-Lanaken du Canal Albert, H.-N.-F. Santilman. *Technique des Travaux*, vol. 16, no. 1, Jan. 1940, pp. 25–47. Design, construction, and equipment of Lanaye-Lanaken section of Albert Canal, Belgium, involving unusually deep cuts (66 m), concrete-lined siphon, steel bridges, concrete bridges, locks, etc.; cost over 686,000,000 Belgian francs.

RIVERS, IMPROVEMENT. Eine Flusskanalisierung, E. Witte. *Bautechnik*, vol. 18, no. 2/3, Jan. 19, 1940, pp. 21–25. Review of methods of river improvement by construction of levees and regulating weirs; types of movable weirs; elimination of vibration of movable weirs; electric heating of movable weirs for prevention of ice formation.

MATERIALS TESTING

CONCRETE. Influence of Cement and Aggregate on Concrete Expansion, T. E. Stanton, Jr. *Eng. News-Rec.*, vol. 124, no. 5, Feb. 1, 1940, pp. 59–61. Report on laboratory studies of causes of deterioration of concrete pavement in California, showing that relatively high alkali content in cement caused destructive chemical combinations when chart and shale were present in aggregates.

CONCRETE. Le module d'élasticité du béton, J. Bolomey. *Technique des Travaux*, vol. 15, no. 12, Dec. 1939, pp. 591–599. Analysis of original experimental data on determination of modulus of elasticity of concrete.

CONCRETE REINFORCEMENT. High Yield-Point Steel as Tension Reinforcement in Beams, B. Johnston and K. C. Cox. *Am. Concrete Inst.—J.*, vol. 11, no. 1, Sept. 1939, pp. 65–80. Results of tests of 32 rectangular concrete beams reinforced with four different types of high yield point steels; stress strain and load deflection diagrams for beams with different types of reinforcing; relation between structural yield and ultimate strength of beams and total yield strength of reinforcing steel; effect of bond on total number of cracks at ultimate load.

SOILS. Mobile Soils Laboratory, G. H. Dent. *Roads & Streets*, vol. 83, no. 2, Feb. 1940, pp. 54 and 56. Description of trailer-mounted field laboratory for soil testing developed by Maryland State Roads Commission; advantages of mobile laboratories.

PORTS AND MARITIME STRUCTURES

REVIEW. Harbours and Waterways in 1939, *Engineer*, vol. 169, nos. 4383, 4384, and 4385, Jan. 12, 1940, pp. 31–33; Jan. 19, pp. 55–56; and Jan. 26, pp. 80–82. Review of developments in Britain and Ireland, Europe, Near East, Africa, Asia, America, and Australia.

ROADS AND STREETS

CONCRETE. Experiments with Continuous Reinforcement in Concrete Pavements, E. C. Sutherland and S. W. Benham. *Pub. Roads*, vol. 20, no. 11, Jan. 1940, pp. 205–214 and 218–219. Construction of experimental concrete section on Indiana highway for study of possibilities of pavement slab designs in which frequency of constructed transverse joints is reduced through use of continuous, bonded steel reinforcement; details of joints spaced 20 to 1,080 ft apart; program of observations, particularly on crack formation in concrete.

COTTON MATS. Cost of Curing Concrete Pavements with Cotton Mats, R. A. Marr, Jr. *Pub. Roads*, vol. 20, no. 11, Jan. 1940, pp. 215–216 and 219. Analysis of data from 19 states, indicating that cost of curing concrete pavements with cotton mats should not exceed that of other accepted methods; special advantages of concrete curing with cotton mats.

CURVES. Vision Distance Over Vertical Road Curves, W. F. Cassie. *Surveyor*, vol. 97, no. 2502, Jan. 5, 1940, pp. 3–5. Theoretical mathematical discussion of method for determining length of vertical curve, inserted between two opposing gradients, which will provide satisfactory sight distance over summit; charts and tabulated design data.

DESIGN. Divided Highway Design—II—Design of Median Strips. *Eng. News-Rec.*, vol. 124, no. 9, Feb. 29, 1940, pp. 48–51. Trends in design of separating strips; determination of safe turning widths at intersections; new rational practice data.

DESIGN. Highway Right-of-Way, W. A. Clarke. *Eng. & Contract Rec.*, vol. 53, no. 4, Jan. 24, 1939, pp. 10–15. Discussion of principal factors in design of roads, including curvature, gradient, cross section, and width of right of way; benefits of securing ample land. Before Can. Good Roads Assn.

HIGHWAY ADMINISTRATION. National Road Building, T. H. MacDonald. *Roads & Streets*, vol. 82, no. 12, Dec. 1939, pp. 50, 52, 54, and 56. Clearing house activities of American Association of State Highway Officials; results of cooperative highway operations; record of state-federal highway improvement; principal elements of highway planning surveys; highways and national defense; federal assistance in acquiring rights of way. Before Am. Assn. State Highway Officials.

HIGHWAY ENGINEERING, RESEARCH. Idaho Builds Laboratory to Expand Highway Facilities, C. C. Hallvik. *Western Construction News*, vol. 15, no. 2, Feb. 1940, pp. 60–62. Description of building and facilities of new University of Idaho highway research laboratory, at Boise, Idaho.

MAINTENANCE AND REPAIR. New Idea in Street Repair, L. H. Taylor. *Western Construction News*, vol. 14, no. 12, Dec. 1939, pp. 400–401. Method of street repairs developed in Oakland, Calif., by bituminous patching consisting of concrete aggregate material and emulsified asphalt put through concrete mixer, under careful control and placed by concrete finishing methods; costs.

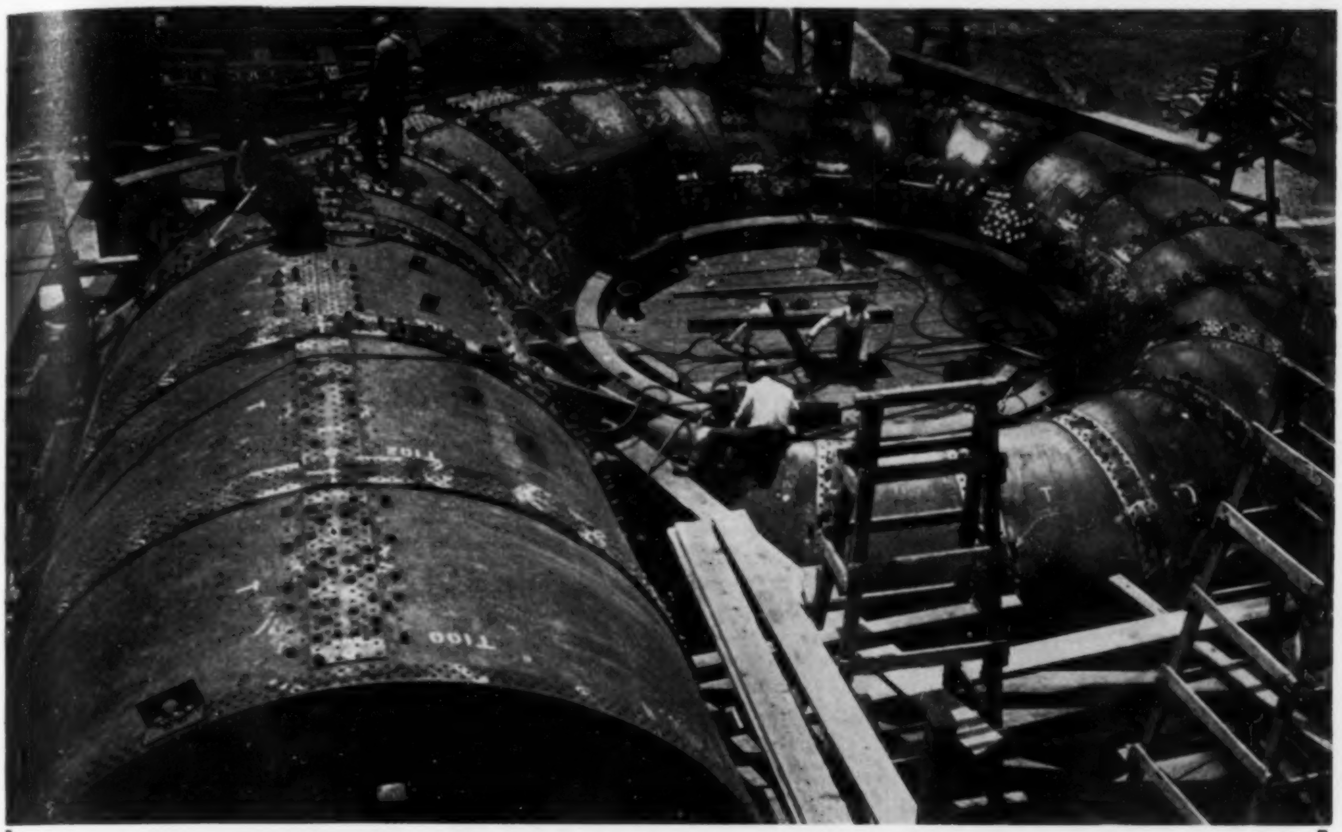
MATERIALS, SPECIFICATIONS. British Standard Specification for Sizes of Road Stone and Chippings. *Brit. Standards Instn.—Brit. Standard Specification, No. 63*—1939, 17 pp. Specification intended to cover supply of nominal single-sized stone and chippings (including gravel and slag) for use in construction and maintenance of highways.

NATIONAL DEFENSE. Roads for National Defense. *Eng. News-Rec.*, vol. 124, no. 3, Jan. 18, 1940, pp. 77–92. Symposium including following: Roads for National Defense; War and Interregional Highway Plan, H. S. Fairbank; Loads and Roads for War and Peace, L. S. Tuttle; Highway Bridges Under Wartime Loads, G. S. Paxson.

NOVA SCOTIA. Highway Progress in Province of Nova Scotia, R. W. McColough. *Eng. & Contract Rec.*, vol. 53, no. 3, Jan. 17, 1940, pp. 9–11. Progress report on addition of 56 miles of paving in 1939, bringing total paved mileage in Nova Scotia to 938; 91 miles scheduled for 1940.

PALESTINE. Haifa-Baghdad Road, R. Briggs. *Roy. Engrs. J.*, vol. 53, Dec. 1939, pp. 497–519, supp. plates. Report on methods and equipment used in construction of part of Haifa-Baghdad highways, about 600 miles total length, paralleling petroleum pipe line of Iraq Petroleum Company.

PARKWAYS. Toll Parkway Proposed for Los Angeles. *Eng. News-Rec.*, vol. 124, no. 9, Feb. 29, 1940, pp. 62–63. Features of proposed 6-mile, 6-lane parkway from downtown Los Angeles to Hollywood, Calif., to be built with toll refunding revenue bonds; estimated cost $20,000,000.



RAILROAD CROSSINGS, SIGNALS AND SIGNALING. Interlockings Installed at Two Crossings. *Ry. Signaling*, vol. 33, no. 3, Mar. 1940, pp. 143–145 and 160. In order to provide increased safety and expedite train movements, three roads operating in Chicago area have completed installation of interlockings, controlled by table interlockers, at two railroad grade crossings within city limits; plants include home and approach signals for protecting and directing train movements, but no switches or derails, operated by interlockings, are involved.

ROAD MACHINERY, PAVERS. Dual-Drum Paver Approaches Capacity Production on Pennsylvania Turnpike. *Construction Methods*, vol. 22, no. 1, Jan. 1940, pp. 52–55, 108, and 110. Report on performance of dual-drum paver placing concrete on subgrade of Pennsylvania Turnpike at average rate of 78 cu yd per hour.

SNOW CONTROL. Methods of Snow-Drift Prevention, E. A. Finney. *Earth Mover*, vol. 26, no. 10, Oct. 1939, pp. 7–9 and 18. Report on results of investigations showing that snowdrift may be prevented by proper road design and roadside betterment. From *Mich. State College—Eng. Experiment Station—Bul. No. 86* (date not given).

STABILIZATION. Stabilized Soil Mixtures, E. A. Willis. *Roads & Streets*, vol. 83, no. 2, Feb. 1940, pp. 37–44. Results of tests on circular tracks by Division of Tests, Public Roads Administration; results from studies of sand clay, sand clay gravel, and crusher run materials; use of water-retentive chemicals, sodium chloride, and calcium chloride; effect of freezing and thawing; effect of plasticity index and grading.

UNITED STATES. Quarter-Century of Highway Progress. *Eng. News-Rec.*, vol. 124, no. 3, Jan. 18, 1940, pp. 111–118. Symposium presenting pictorial review of progress in highway construction in United States, including following: Progress in Methods and Machines; Progress in Structures and Roadway; Errors in Record.

WIRE ROPE, SPECIFICATIONS. Recommended Wire Rope Lines. *Roads & Streets*, vol. 83, no. 3, Mar. 1940, pp. 54–55. Specifications for wire ropes needed on major road building and maintenance equipment, recommended lines for road construction and maintenance equipment.

SEWERAGE AND SEWAGE DISPOSAL

ACTIVATED SLUDGE. Studies of Sewage Purification—XI, C. C. Ruchhoft, J. F. Kachmar, and W. A. Moore. *Sewage Works J.*, vol. 12, no. 1, Jan. 1940, pp. 27–50. Results of experimental study of removal of glucose from substrates by activated sludge; review of literature; effect of pH; glucose removal rates in absence of oxygen; effect of prolonged reaeration; effect of repeated glucose feeding; effect of chlorination. Bibliography.

CHEMICAL PROCESS. Influence of Activated Silica in Sewage Coagulation, C. W. Christenson and I. Lavine. *Am. Inst. Chem. Engrs.—Trans.*, vol. 36, no. 1, Feb. 25, 1940, pp. 71–88, (discussion) 88–90. Addition of about 10 ppm of activated silica (acidified sodium silicate) to 50 ppm of alum on coagulating Grand Forks sewage found to be most beneficial; silicate solution must be aged for definite period before use, depending on pH; use of this quantity of activated silica permits reduction at least 40% in amount of alum necessary for good coagulation of sewage. Bibliography.

DEVELOPMENTS IN 1939. Developments in Sewage and Waste Treatment During 1939, W. Rudolfs. *Mun. Sanitation*, vol. 11, no. 2, Feb. 1940, pp. 57–63. Review of year's progress in sewage treatment in United States and abroad; mechanization; sludge disposal; digestion; activated sludge; sewage treatment for fairs; filters and straining devices; water disposal progress; research; methane-producing bacteria.

DISPOSAL PLANTS, DARIEN, CONN. Sewering Town on Sound, C. L. Bogert. *Mun. Sanitation*, vol. 11, no. 2, Feb. 1940, pp. 82–84 and 109. Description of new sewage disposal system of Darien, Conn., population 3,000, consisting of 33 miles of sewer, two pumping stations, and plant for primary treatment and chlorination; features of outfall sewer; costs.

DISPOSAL PLANTS, LABORATORIES. Equipping Sewage Plant Laboratory, N. C. Wittwer. *Water Works & Sewerage*, vol. 87, no. 2, Feb. 1940, pp. 70–75. Features and lists of equipment for sewage disposal plant laboratories, particularly for smaller plants; furniture specifications; permanent apparatus; minor equipment items; reagents and chemicals; summary of costs.

DISPOSAL PLANTS, LABORATORY CONTROL. Laboratory Control of Operation of Richmond-Sunset Sewage Treatment Plant, K. Fraschina. *Sewage Works J.*, vol. 12, no. 1, Jan. 1940, pp. 94–96. Functions and routine of laboratory of 15-mgd sewage disposal plant at Richmond, Calif.

DISPOSAL PLANTS, LEOMINSTER, MASS. Activated Sludge Plant Corrects Pollution Litigation, E. S. Chase. *Mun. Sanitation*, vol. 11, no. 3, Mar. 1940, pp. 143–146. History and construction of activated sludge sewage disposal plant of Leominster, Mass., having capacity over 3.5 mgd; operation of primary sedimentation tanks, aeration tank, and digestion and storage tanks; sludge beds; analyses of sewage and effluents.

WATER POLLUTION, UNITED STATES. Pollution Control—Where Does It Stand? A. Wolman. *Mun. Sanitation*, vol. 11, no. 2, Feb. 1940, pp. 64–66. Review of progress in treatment of sewage for prevention of water pollution in United States; financing and administration of stream pollution control in United States.

STRUCTURAL ENGINEERING

ELASTICITY. Remarques sur l'équilibre d'un solide élastique, homogène et isotrope, A. Charrueau. *Annales des Ponts et Chaussées*, vol. 109, no. 8, Aug. 1939, pp. 169–194. Theoretical mathematical discussion of equilibrium of homogeneous, isotropic, elastic solids.

FRAMED STRUCTURES, CONCRETE. Tests of Considere Hinges Under Direct Stress, Bending and Shear, G. C. Ernst. *Am. Concrete Inst.—J.*, vol. 11, no. 1, Sept. 1939, pp. 49–63. Analysis of results of University of Maryland tests of principal hinge types used in rigid frame construction; design procedure; design chart for Considere reinforced concrete hinge. Bibliography.

FRAMED STRUCTURES, DESIGN. Design Coefficients for Building Frames, A. J. Boase and J. T. Howell. *Am. Concrete Inst.—J.*, vol. 11, no. 1, Sept. 1939, pp. 21–36. Analysis of building frames based on principles of continuity; determination of approximate stiffnesses; tables for determination of moments and shear; numerical examples.

FRAMED STRUCTURES, STRESS ANALYSIS. General Formulae of Moment-Distribution and Their Application to Space Frames, D. A. Morelli. *Instn. Engrs. Australia—J.*, vol. 12, no. 1, Jan. 1940, pp. 1–9. Review of previous investigations; derivation of fundamental equations of general case by short and simple analytical procedure, which leads to recognition of analogy between moments at joint and ellipsoid of stress; maximum stresses in polygonal frame; experimental check of analysis; sample solution.

FRAMED STRUCTURES, VIBRATIONS. Natural Period of Vibration of Building Frames, J. E. Goldberg. *Am. Concrete Inst.—J.*, vol. 11, no. 1, Sept. 1939, pp. 81–95. Outline of method for direct analytical determination of natural period of simple, free vibration of building, frames of open panel, shallow braced type, with particular emphasis on case of intermediate and moderately tall buildings; determining deflection curve; numerical examples.

HANGARS, CONCRETE. Monolithic Concrete Construction for Hangars, J. E. Kalinka. *Military Engr.*, vol. 32, no. 181, Jan.–Feb. 1940, pp. 54–56. Features of ZO system of roof construction for reinforced concrete hangars; types of domed shell roofs; multiple carrying action of domes; advantages of monolithic concrete construction.

HANGARS, DESIGN. Some Aspects of Aero-Hangar Design, A. M. Hamilton and E. B. Cocks. *Instn. Civ. Engrs.—J.*, no. 4, Feb. 1940, pp. 305–336, supp. plates. Results of experimental model study of effects of wind forces on large sheds with low-pitched roofs of wide span; design of lightest possible building of this type which will be rigid and stable under all weather conditions; standardization; analysis of portal frame; use of models; dead load capacity of rib; door and frontage forces; shear loads and corner loads in rib.

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INDEX OF PRODUCTS

AERIAL CABLEWAYS AND TRAMWAYS
American Steel & Wire Co.

AIRPORT DRAINAGE
Lock Joint Pipe Co.

ALUMINUM, STRUCTURAL
Aluminum Co. of America

ANCHORS FOR FENDERS AND TUNNEL FORMS
Richmond Screw Anchor Co., Inc.

ASPHALT
Standard Oil Co. (Indiana)
Texas Co.

BARGES, STEEL
American Bridge Co.
Chicago Bridge & Iron Co.

BARS, ALUMINUM
Aluminum Co. of America

BARS, IRON AND STEEL
Carnegie-Illinois Steel Corp.

BINS, STORAGE
American Bridge Co.
Chicago Bridge & Iron Co.

BLOWER PIPE, STEEL, FOR VENTILATION PURPOSES
Lock Joint Pipe Co.

BORINGS, TEST
Raymond Concrete Pile Co.
Spencer, White & Prentis, Inc.

BRIDGES
American Bridge Co.

BRIDGE CABLES
American Steel & Wire Co.

BRIDGE FLOORS, GRATING
Irving Iron Works Co.

BRIDGE PLANKS, MINERAL SURFACED ASPHALT
Johns-Manville Corp.

BUILDINGS, STEEL
American Bridge Co.

CAISSONS
Raymond Concrete Pile Co.
Spencer, White & Prentis, Inc.

CEMENT, HIGH - EARLY - STRENGTH PORTLAND
Lone Star Cement Corp.

CEMENT, PORTLAND
Lone Star Cement Corp.
Portland Cement Assn.

CLOTH PRINTS
Ozalid Corp.

COATINGS, PROTECTIVE
CopperCote, Inc.

COLD MIX
Texas Co.

CONCRETE ADMIXTURES
Johns-Manville Corp.

CONCRETE FORM ANCHORS, WOOD OR STEEL FORMS, LIGHT AND HEAVY CONSTRUCTION
Richmond Screw Anchor, Inc.

CONCRETE MIXERS
Chain Belt Co.

CONCRETE PUMPS
Chain Belt Co.

CONCRETE REINFORCEMENT
American Steel & Wire Co.
Carnegie-Illinois Steel Corp.

CONTRACTORS
Raymond Concrete Pile Co.
Spencer, White & Prentis, Inc.

CONVEYORS
Chain Belt Co.

CORRUGATED SHEETS, ALUMINUM
Aluminum Co. of America

CORRUGATED SHEETS, ASBESTOS-CEMENT
Johns-Manville Corp.

CULVERTS, ASBESTOS-CEMENT
Johns-Manville Corp.

CULVERTS, CAST IRON
Cast Iron Pipe Research Assn.
U. S. Pipe & Foundry Co.

CULVERTS, REINFORCED CONCRETE
Lock Joint Pipe Co.

DRAFTING MACHINES
Keuffel & Esser Co.

DRAFTING (WHITEPRINTS)
Ozalid Corp.

DRAINS, REINFORCED CONCRETE
Lock Joint Pipe Co.

DRY DEVELOPED PRINTS
Ozalid Corp.

DUST CURE
Texas Co.

ENGINES, STATIONARY, DIESEL AND GAS
Caterpillar Tractor Co.

ENGINEERS
Raymond Concrete Pile Co.
Spencer, White, & Prentis, Inc.

EXPANSION JOINTS, ASPHALT OR CORK
Johns-Manville Corp.

FLOORING, ALUMINUM
Aluminum Co. of America

FLOORING, ASPHALT TILE
Johns-Manville Corp.

FLOORING, GRATING
Irving Iron Works Co.

FLOORING, STEEL
Carnegie-Illinois Steel Corp.

FOIL PRINTS
Ozalid Corp.

FORM CLAMPS, CONCRETE WALL CONSTRUCTION
Richmond Screw Anchor Co., Inc.

FORM TIES, CONCRETE WALL CONSTRUCTION
Richmond Screw Anchor Co., Inc.

FOUNDATIONS
Raymond Concrete Pile Co.
Spencer, White, & Prentis, Inc.
Union Metal Mfg. Co.

GASHOLDERS
Chicago Bridge & Iron Co.

GATES, FLOOD AND SLUICE
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Brown & Brown, Inc.

GRADERS, ELEVATING
Caterpillar Tractor Co.

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Caterpillar Tractor Co.

GRADERS, TRACTOR OR HORSE DRAWN
Caterpillar Tractor Co.

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Irving Iron Works Co.

HANGING DEVICES FOR CONCRETE FORMS
Richmond Screw Anchor Co., Inc.

INKS, WATERPROOF, PIGMENT, DRAWING
Keuffel & Esser Co.

INSTRUMENTS
Buff & Buff Co.
Keuffel & Esser Co.
Polarizing Instrument Co.

LETTERING GUIDES
Keuffel & Esser Co.

LEVELS
Buff & Buff Co.
Keuffel & Esser Co.

NICKEL AND ITS ALLOYS
International Nickel Co., Inc.

OPAQUE TYPEWRITER RIBBONS
Ozalid Corp.

PAINT PIGMENT, ALUMINUM
Aluminum Co. of America

PAINTS
CopperCote, Inc.

Continued on page 29

ONCRETE

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